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European Free Trade

HOPES of an early resumption of the seventeen-nation talks on the European Free Trade Area project have been revived, at the time of writing this article, as a result of the communique issued by the six-nation Common Market's Executive Commission. This communique said that talks between the Commission's President and the six-member Governments on how to break the present impasse were "extremely satisfactory and constructive." It also states that talks "have shown that there is a common will for the adoption of a provisional solution to the problems arising on January 1 next pending the result of studies at present in progress for definitive solutions."

In reviewing the present economic situation, Sir Norman Kipping, Director-General of the Federation of British Industries, said in London last week that he attributed the falling level in fixed investment in the private sector of industry in large measure to the doubts and confusion which existed about future market prospects, especially in Europe. Elaborating this point, Sir Norman said that he felt Monsieur Soustelle had rendered a service by bringing out sharply and clearly what the facts were as regards the French attitude to the Free Trade Area proposals. This had brought home vividly, not only to the Western European countries outside the "Six" but also to the Six themselves, what all of us would stand to lose if we had to face final failure to reach agreement. The six countries of the European Economic Community, apart from the prospective loss of free and unlimited access to large and prosperous markets, would also have to share with the rest of us the consequences of a grave weakening, if not the breakdown, of the O.E.E.C. and the E.P.U. There were signs that this was already being realized, and some most helpful suggestions had already been put forward for ways in which the full effect of sharp discrimination within the O.E.E.C. on January 1 next might be avoided.

It is common ground that a close economic association with Europe, whether by means of a Free Trade Area or in some other form, is vital for the prosperity of Britain and the Commonwealth. It is equally necessary that all sections of the non-ferrous metals industry should keep a close watch upon the present situation, and we are sure that the trade associations connected with the industry are indeed keeping their attention fixed on the problems which must arise whether the Common Market project succeeds or not. Considered from a purely short-term view, there might be advantages for the U.K. to remain outside this Common Market area, although for the metal industries it would not necessarily follow that this would ensure cheaper metals. In the longer view, however, it has been suggested that there are better prospects for this country by being members of the scheme. It should not be forgotten that the Common Market involves something like 160 million people, representing a potential economic bloc comparable to the United States and Soviet Russia. With the tendency towards loosening the bonds of Imperial Preference, this country might find it well nigh impossible to maintain her economy if she failed to take part in the Free Trade area.

Sir Norman Kipping pointed out that there were three things the United Kingdom could not contemplate: first, it could not as a country go backwards to a restrictive bilateralism; second, it could not afford to become a high cost economy; and third, it could not give up a high degree of tariff autonomy.

Out of the MELTING POT

Nth Degree

A GOOD deal of care is taken in electroplating to ensure that the deposit will have a good adherence. Under severe, and sometimes far from severe, service conditions, the various steps taken to that end may turn out to have been inadequate, with the only too familiar consequences. In the case, now rapidly becoming of historical interest, of aluminium alloy propeller blades nickel plated to protect them against erosion by water, sand, and other airborne particles, these familiar consequences of inadequate adherence could not be tolerated, and it is interesting to note that one of the solutions suggested involved the abandonment of the metal-to-metal contact and ensuring adherence by providing an adhesive bonding layer between the basis metal and the electroplated nickel layer. Unfortunately, this practice is unlikely to find wide adoption as the answer to the problem of obtaining adherent electrodeposits. Simple in principle, the method is remarkably elaborate in practice. A start is made by cleaning the blade in accordance with accepted practices. The blade may then be anodized, though this is not essential. It is then given a 0·00025 in. thick coating of an adhesive containing zinc chromate corrosion inhibitor. There follows the application of a 0·0005 in. thick coating of chlorinated rubber and chloroprene adhesives. There then follows the application in one or, preferably, several steps of a layer or layers of a mixture of chloroprene adhesive and a catalyst, with intermediate drying and baking of the layers, the total thickness of which is about 0·002 in. This is followed by the application of a coating or coatings of the mixture of chlorinated rubber and chloroprene adhesive, to the final coating of which, while it is still wet, is bonded a conductive layer of chloroprene compound containing an electroconductive carbon black in colloidal dispersion. After the above preparation, the blade can be nickel plated from a sulphate or sulphamate bath, preferably in two stages.

Too Many?

FOR how long was that mythical designer *par excellence*, who finally designed a part that could not even be cast, left to enjoy his triumph? The familiar story does not say. In view of the absence of uncastable or otherwise unmanufacturable parts, however, it has to be concluded that his triumph was short-lived. Production engineers, too, have their triumphs. Given such triumphs, both real and imaginary, on both the design and production side, progress must be, and indeed is, rapid. In the majority of cases, moreover, fruitful collaboration or consultations are the order of the day. Situations in which the two sides are at loggerheads, with the designers evolving impossible designs and the production people exercising their ingenuity on production methods for them regardless of cost, are much more amusingly imaginary than real. Does all this mean that everything on the design-production front is satisfactory? It does not. Advances are certainly numerous, but this fact may easily obscure the danger that lurks in numbers. Taking the design side on its own, numbers resulting from sheer exuberance, coupled with a firm trust in the abilities of methods of production, only too often result in numbers exceeding the limit where they cease to be a blessing. And so far as the firm trust in methods of production is concerned, how much of it is blind because of ignorance due to the overwhelming numbers, which bid fair to rival those of designs? And, on the production side, do not these numbers also suggest that efforts may perhaps have been spread too evenly? Can it be claimed that each and every production method has received all the research and development efforts that it deserves? Has there been no jumping from method to method? Is the popularity of methods that are fashionable to-day really deserved? Would not the benefits to be expected make it worth while concentrating available efforts on a more limited number of production methods?

Electroless Brazing

ELECTROFORMING and the production of metal powders are the two uses of electrodeposition, other than electroplating, that come readily to mind when possible applications of the process are considered. That there are only two, and the fact that possible applications of electrodeposition other than for electroplating do not seem to come up very often for consideration, are unfortunate. Indeed, the state of affairs is such that progress beyond the existing boundaries must be traced through out-of-the-way references and the claims of patent specifications, the utility of which it is difficult to gauge. It is equally difficult to understand the reluctance of making wider use of a method of producing metals and alloys without resort to melting and casting, with all their drawbacks and difficulties, and the reluctance of making more use of the imagination for the purpose of devising methods of "shaping" the metals or alloys produced by electrodeposition into semi-manufactured or finished products, and parts obtainable with little or no resort to mechanical working, with its usual demands for heavy machinery. The above advantages of electrodeposition become especially useful when the quantities of metal, or the dimensions of the parts being produced, are relatively small and, therefore, difficult to process by conventional methods of melting, casting and/or fabrication. The production of metal foil by electrodeposition is one example of such a situation. The production of fine grids and meshes is another. The production of thin wire by electrodeposition combined with a limited amount of drawing could be another. The use of electrodeposition as a means of providing small amounts of metal required in metal-joining operations has also been suggested. Such electrolytic welding methods must allow for the limitations imposed by throwing power and effects of screening. Since these factors do not operate in the same way in electroless plating, the latter has now stolen yet another march on electrodeposition. It has been put to use for providing the metal required for bonding the elements of such complicated assemblies as heat exchangers, the cellular cores of rotatable regenerators of gas turbines, and the like. The hypophosphite nickel plating process is used. The parts are assembled and held together under adequate pressure, and are then immersed in the plating solution. Plating may be continued until sufficient of the nickel-phosphorus alloy has been deposited to form adherent fillets between the parts to be bonded. The strength of the joints can afterwards be increased by heating, with or without melting of the deposited metal.

Skinner

METALLURGICAL FACTORS AFFECTING SELECTION OF MATERIALS

Steels for Extrusion Tools

By F. RODGERS, A.Met. A.I.M.

The quality of tools for extrusion press operations is of vital importance in economy and efficiency of production. Tool quality is primarily a metallurgical problem, and this Paper, which was presented recently to the Birmingham Metallurgical Society, discusses this problem in detail

ADVANCEMENT in the extrusion process has been made possible only by the closest collaboration between the press designer, the user, and the metallurgist responsible for the supply of the various tools used in the process.

Ideally, the process is simple in that it consists of squeezing a plastic material through a suitable die. It will be appreciated that temperature of the billet or workpiece, and the pressure required for satisfactory extrusion, can vary over a very wide range, dependent upon the material being dealt with.

Temperature ranges for the various alloys extruded on a commercial basis are shown in Tables I-IV.[1]

In order to contain and apply the necessary pressure, it is necessary to employ a massive steel container, usually fitted with a replaceable liner, and, sliding inside this with a predetermined clearance, a ram, capable of exerting the load.

The die is carried in a retractable housing, designed and actuated in such a manner as to provide adequate sealing pressure and, at the same time, sufficient support to the die itself.

Presses for the production of solid and hollow sections can be either horizontal or vertical, each type having its own peculiar advantages, and a typical horizontal installation is shown in Fig. 1.

The problems associated with the various tools essential to both types of press are, in general, closely related, and for the purpose of this article, particular reference will be made to the horizontal type of press. A typical container assembly for such a press is shown in Fig. 2, which also shows the nomenclature which will be used throughout.

Container Assembly

The purpose of the container assembly is to contain the billet and resist the radial pressure exerted during the extrusion stroke. It is normally designed as a two- or three-piece composite assembly, so as to permit of replacement of the inner member or liner which, due to intimate contact with the billet, is subject to an onerous combination of temperature, abrasion and stress.

It is essential that every precaution be taken to ensure that the liner bore does not lose form by the mechanism of radial pressure, as this can result in cracking, or heavy shell. It is, therefore, desirable that the container be capable of withstanding elastically the stress arising in service. The various factors determining this stress are:—

(1) Radial pressure at the bore.
(2) Thermal effects.
(3) Form of container construction.

The practical problems associated with the measurement of the radial pressure arising during the hot extrusion of metals are such that little

TABLE I—EXTRUSION RANGE FOR ALUMINIUM ALLOYS

Material	Composition (per cent)						Extrusion Temp. Range °C. (Approx.)
	Cu	Si	Mg	Mn	Zn	Al	
Aluminium:							
Pure Al						99·5	450-490
Aluminium alloys:							
Al-Mn 1¼		0·6		1·3		Bal.	450-490
Al-Mg 1¼-Mn 1¼		0·6	1·3	1·3		Bal.	410-450
Al-Mg 1-Si ¾		0·7	1·0			Bal.	430-470
Al-Mg 2¾			2·6			Bal.	410-450
Al-Cu 4½-Mg 1½	4·5		1·5	0·6		Bal.	410-450
Al-Mg 5			5·0	0·6		Bal.	390-420
Al-Mg 7			7·0	0·6		Bal.	380-410
Al-Zn 5¾-Mg 2½-Cu 1½	1·5		2·5		5·8	Bal.	360-390

TABLE II—EXTRUSION RANGE FOR MAGNESIUM ALLOYS

Material	Composition (per cent)				Extrusion Temp. Range °C. (Approx.)
	Al	Mn	Zn	Mg	
Magnesium:					
Pure Mg				99·5	280-320
Magnesium alloys:					
Mg-Mn 1½		1·5		Bal.	400-430
Mg-Al 3	3·0	0·2	1·0	Bal.	380-410
Mg-Al 8½	8·5	0·2	0·5	Bal.	350-380
Mg-Al 6	6·0	0·2	1·0	Bal.	360-390

TABLE III—EXTRUSION RANGE FOR COPPER ALLOYS

Material	Composition (per cent)								Extrusion Temp. Range °C. (Approx)
	Cu	Zn	Sn	Al	Pb	Ni	Si	Mn	
Copper:									
Pure Copper	100								800-880
Leaded Copper	99				1				
Copper-Zinc alloys:									
Brass 58:42	58	42							650-700
Brass 58:39:3	58	39			3				
Brass 60:40	60	40							660-720
Brass 63:37	63	37							700-750
Brass 68:32	68	32							700-770
Brass 85:15	85	15							770-800
Brass 90:10	90	10							820-870
Admiralty Brass (70:29:1)	70	29	1						830-850
Aluminium Brass (76:22:2)	76	22		2					830-850
Copper-Zinc-Nickel alloys:									
Nickel Silver	45	43			2	10			730-770
	65	17				18			860-890
Copper-Nickel alloys:									
Cupro-Nickel 70:30	70					30			900-1000
Miscellaneous Copper-base alloys:									
Aluminium Bronze	95			5					830-880
	91			9					850-900
Silicon Bronze	96						3	1	660-690
	96		4						810-840
Tin Bronze	92		8						720-750

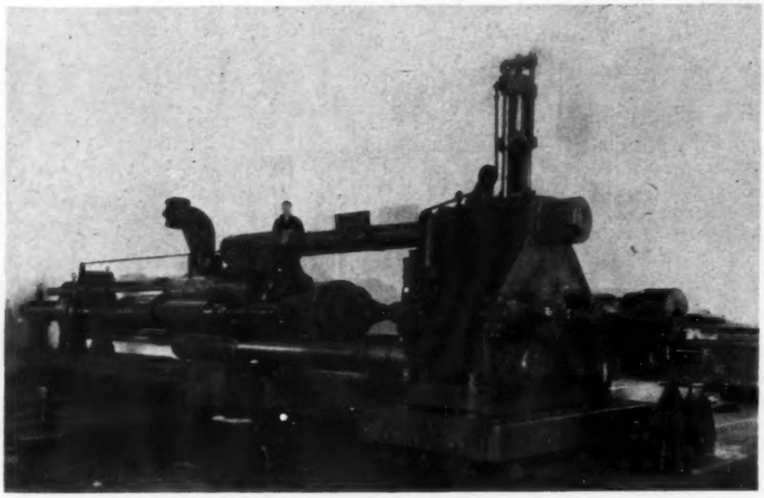


Fig. 1—Typical horizontal extrusion press

TABLE IV—EXTRUSION RANGE FOR NICKEL ALLOYS AND STEEL

Material	Composition (per cent)								Extrusion Temp. Range °C. (Approx.)
	Ni	Cu	Fe	Mn	Si	C	S	Cr	
Nickel	99								1110-1160
Nickel alloys:									
Monel	67	30	1·5	1·0					1100-1130
Inconel	77		7					15	1170-1200
Steels									1050-1250*

**Depending on composition.*

TABLE V—ANALYSIS OF EXTRUSION CONTAINERS

Designation	ANALYSIS (Typical) (per cent)							
	C	Si	Mn	Cr	Ni	Mo	V	W
Hecla 37	·40	·30	·70	—	—	—	—	—
Hecla D17	·60	·30	·70	—	—	—	—	—
Hecla 152	·40	·30	·70	1·00	1·50	·30	—	—
Hecla 138	·30	·30	·60	·60	2·60	·40	—	—
Hecla 138H	·40	·30	·60	·60	2·60	·40	—	—
Hecla 167	·40	·30	·60	1·50	·70	·40	—	—
Hecla 172	·25	·40	·30	3·00	—	·60	·90	·60
—	·32	·30	·85	1·10	—	1·25	·25	—
—	·40	·30	1·30	1·80	—	·20	—	—

A—Die head. B—Wedge block. C—Bolster D—Die holder. E—Die. F—Container. G—Liner holder. H—Liner. J—Pressure disc. K—Mandrel. L—Mandrel holder. M—Hollow Stem.

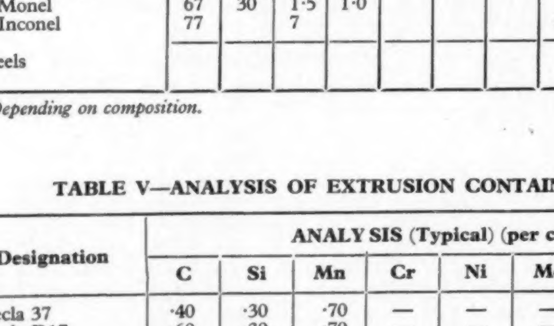


Fig. 2—Arrangement of typical container assembly for use with horizontal extrusion press

information is available. The consensus of opinion seems to be that it can vary between 40 per cent and 70 per cent of the extrusion pressure, i.e. that exerted by the ram. This ratio is obviously dependent upon the temperature and characteristics of the metal in question. The extrusion pressure varies with the stroke position, and typical pressure/stroke characteristics for leaded free-machining brass are shown in Fig. 3; it is interesting to observe the effect of billet temperature. A typical pressure/stroke curve for an austenitic steel of the precipitation hardening type is shown in Fig. 4.

The temperature gradient through the container assembly again defies precise analysis, particularly in those cases where an external heat source is used. The problem is further complicated by the fact that, in addition to the stress generated by thermal effects, the behaviour of the steels used in the construction of the container assembly cannot be accurately predicted.

In the extrusion of copper-base alloys, for example, the temperature of the liner bore may be 550°C., and that of the container adjacent to the heaters 500°C., whilst that at the mid-radius position may be 400°C. Radiation and other heat losses will also give rise to a variation in this temperature gradient along the length of the assembly.

Mention has been made earlier of the fact that the container comprises two or more members. These are normally assembled with an interference fit which serves two useful purposes; first, it minimizes the possibility of lateral movement or slip between the members, and secondly it permits of useful modification of the stress pattern and distribution.

Many workers have investigated the stress pattern believed to exist across the section of extrusion container assemblies, and due regard has been paid to the possible existence of an elastic-plastic relationship.[2,3]

The company with which the author is associated has, over many years, accumulated a vast wealth of experience in this particular field; this has shown that a fair compromise is to ignore, within certain limits, thermal effects, and assume the pressure to be hydraulic in character. This permits of the preparation of a stress diagram of the type shown in Fig. 5. The presentation of the resultant stresses is shown in Fig. 6, and these values are used in the determination of suitable steels.

Extrusion presses vary in capacity from 100 to 8,000 tons, and containers can vary from 6 in. to 80 in. in diameter. As would be expected, these variations, when considered in conjunction with temperature, stress, etc., do not permit of standardization of constructional steels, and the various component parts will be considered in some detail.

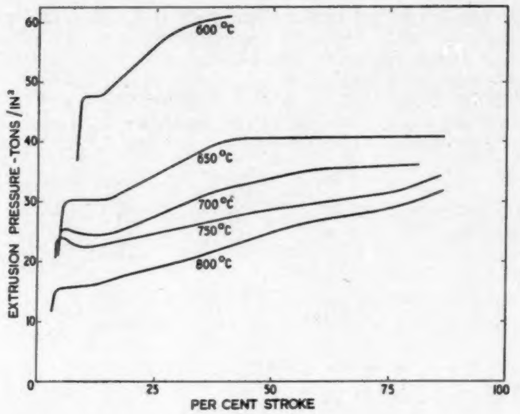


Fig. 3—Extrusion pressure/stroke diagram for leaded free-machining brass (copper: 58 per cent, lead: 3 per cent, zinc: 39 per cent) showing effect of billet temperature

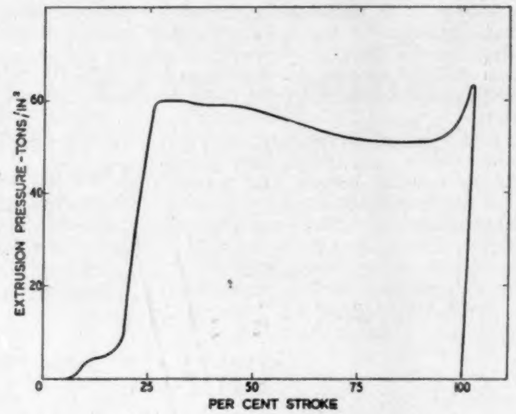


Fig. 4—Extrusion pressure/stroke diagram for Resista P.H. steel. Billet temperature 1,225°C

The Container

It has been mentioned above that the container must accommodate the operational stress within its elastic range and, as in the majority of cases, this stress is of the order of 30-35 tons/in², an alloy steel is desirable. The actual choice is determined by the mass of the container in conjunction with considerations of hardenability; thus, in the case of comparatively small units a low alloy steel is satisfactory; in the case of larger containers it is necessary to employ steels of higher alloy content. Typical container compositions are presented in Table V.

Long exposure to temperatures of the order of 500°C. can result in the onset of embrittlement. Whilst this will not, except in the most severe cases, adversely affect the properties of the container at the operational temperature, it can cause failure in a brittle manner during heating from room temperature.

A high impact transition temperature is also capable of producing a similar effect, and this aspect must be considered in the determination of steels suitable for extrusion containers.

A direct result of embrittlement is inability of the steel to adjust itself to stress raisers by the mechanism of plastic deformation, and thus it is desirable that particular attention be paid to the design of keyways, etc., on the outer surface of the container. It is interesting to note that McCrae[4] and others, during the course of examination of vessels subject to internal pressure, were led to the conclusion that failure almost invariably commences at the outer surface.

Should a steel be subject to embrittlement, then it is possible to apply a partial corrective in the form of periodic heat-treatment.

The most complex container problems can arise in the extrusion of certain aluminium alloys, where, by virtue of the narrow temperature range and the slow rate of extrusion, it is essential to maintain the container

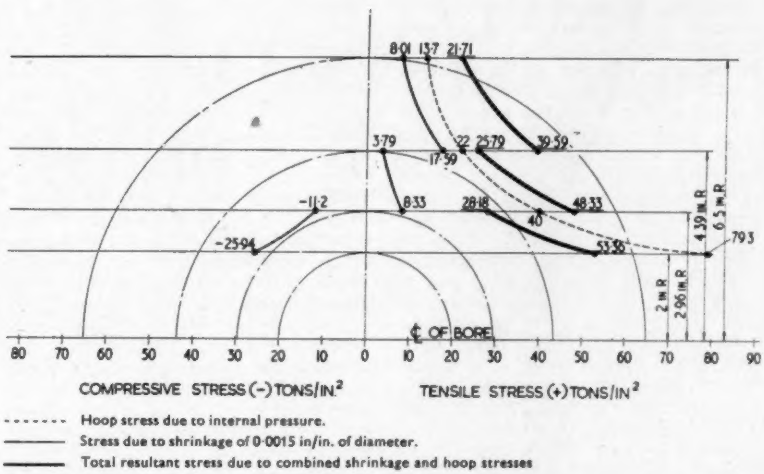


Fig. 5—Distribution of stresses in high-pressure vessels: internal working pressure 65·6 tons/in²

ENQUIRY RECORD

CUSTOMER: Extrusions Ltd. DATE: 14-3-46. WORKS ORDER: 2584
CUST. DRG. No. P.2134 H. LTD. DRG. No. Z.17654

Bore	Mean O/D. Liner	Mean O/D. Liner Holder	O/D. Container
16 in.	24 in.	—	48 in.

Total Pressure: 5,000 tons
Internal Pressure: 25·2 tons/in²

		Max. Stress (tons/in²)	Steel and Treatment
Liner	Inside Outside	14·5 8·3	Hecla 160C Oil quenched and tempered
Liner Holder	Inside Outside	— —	
Container	Inside Outside	28·4 9·5	Hecla 138H Oil quenched and tempered

Shrinkage allowance per inch of diameter: On liner ·0015 in.
On liner holder —

Remarks: Stress on ram .. .. 70·6 tons/in² Hecla 135 steel
Stress on die holder .. 42·8 „ Hecla 116 steel

To be used for the production of 70/30 brass tubes, billet temperature 850°C., estimated container temperature 350°C.

Fig. 6—Typical extrusion data record

assembly at a temperature approximating to that of the billet. Should this require a container temperature in excess of 450°C., then due regard must be paid to the possibility of creep in service.

Other industrial applications, particularly the gas turbine, have greatly accelerated the interest and research into steels capable of resisting creep, and considerable data are available. These, in the main, are confined to relatively small forgings, and the metallurgical, as well as manufacturing, problems are formidable in the case of large forgings of the type used by the aluminium extrusion industry.

Careful attention to all aspects of manufacture, however, enables large container forgings in steels of the 3 per cent Cr-Mo-V-W type to be produced.

Liner Holder

The function of the liner holder can, in many respects, be likened to that of the container, and similar metallurgical considerations apply. The mass is normally much less than that of the container, and thus it is usual to find that this component is made in a relatively low alloy steel.

References

1 E. K. L. Haffner and R. M. L. Elkan; *Metallurgical Reviews*, 1957, **2**, No. 7, 263.

2 M. R. Horne; *Proc. Inst. Mech. E.*, 1955, **169**, No. 4.

3 H. M. Hiller; *Metall*, December, 1953.

4 A. E. Macrae; "Overstrain of Metals," H.M. Stationery Office, London, 1930.

(*To be continued*)

Tinning Wire for Soldering

TINNING of copper wires has been carried out for many years in the electrical industry with two main objects in mind. One is the prevention of chemical interactions between copper and rubber in rubber-covered cables. The other main reason for tinning, however, is to preserve permanently the original good solderability of the freshly-drawn copper wire. Because it is not known at what point the copper wire or cable may have to be soldered, it always proves to be economically sound to use a tinned copper wire so that joints can be made with the minimum expenditure of trouble and time; the alternative is to leave the wires uncoated and to carry out a tinning operation on the ends where they have to be soldered.

Copper wire has usually been tinned by the hot-dipping process, in which, after passing through cleaning baths, pickling baths, and flux, it runs through a bath of molten tin, where it becomes coated. Because of the very large quantities required, the tinning process has to be carried out quickly, which means that the single strands of wire must pass rapidly through the bath. Usually, there are a dozen strands side by side, each being under individual control. As it leaves the bath, the wire drags out molten tin, some of which drains back, but most of it is removed by wiping between rubber blocks which are applied, generally one on each side, so as to leave only a thin coating on the wire. The thickness of the tin coating is controlled by the pressure of the rubber blocks on the wire. The wear and tear on the rubber blocks is rapid, and continual adjustments have to be made to ensure that the wire emerging from the blocks is sufficiently true to gauge. It is not easy to ensure that the grip of the plug around the wire shall be everywhere uniform, and, if it is not, the coating of tin may be thin at some points and thicker at others.

A hot-tinned copper wire on which there is sufficient tin is readily solderable because, as soon as it is brought to soldering temperature, its tin coating is molten and merges completely with the molten solder.

An alternative method of tinning wire is by electrodeposition. In this method, the copper wire is degreased and passed through electroplating baths, either sodium or potassium stannate, stannous sulphate, or fluoborate. It is practicable to build up a coating comparable in thickness to a hot-dipped tin coating, say from 0·0001-0·0003 in., but it is generally not economic to allow plating time for such thicknesses to be built up. This is, no doubt, why electro-coatings of tin on wire are commonly found to be as thin as 0·00002 in. and 0·00003 in. (0·0005 up to 0·00075 mm.). One important disadvantage is the absence of an intervening layer of copper-tin compounds which are, in effect, the cement which holds the tin on a hot-dipped copper wire. Without this "cement," the tin coating often dissolves in the molten solder, and leaves the wire bare of tin and almost unsolderable. Further, after storage for a few weeks the wire may become difficult to solder.

It is clear that electro-tinned wires may be unsuitable for use as the connecting wires of electronic components, particularly where the method of assembly is by simple immersion in molten solder, as in the printed circuit method. For this method to be successful, the ends of the connecting wires of all the components must be easily solderable. It is not usually practicable at the assembly plant to treat the connecting wires so that their ends become solderable.

A test, described in *Tin and Its Uses*, devised by H. Johnen for the comparison of the quality of solders, but which should be applicable for the testing of solderability of wire samples, provided the same reference solder is used, is as follows:—

Four or five wires, each 1 m. long and of 0·2 mm. diameter, are twisted together by clamping one end in a lathe rotating at 25 r.p.m., until 38 revolutions have been made. Then 150 gm. of solder are melted in a dish, the wire spiral is dipped in aqueous solder flux and the end is then placed in the dish so that only the regularly twisted portion extends above the solder. After 30 sec., the spiral is taken out of the solder and, after solidification, the wires are untwisted so as to facilitate the measurement of the height of climb, which is generally 1 in. or a little more (20 to 35 mm.) when the temperature is from 300° to 400°C. The actual height of climb of the solder from the level in the pot is a measure of the quality of the solder or, provided a standard solder is used, of the solderability of the wire samples. The flux used is a solution of zinc chloride in water having a specific gravity of 1·6.

Men and Metals

It is announced that **Admiral Sir Ralph A. B. Edwards** has joined the board of Elliott Brothers (London) Ltd. Until he retired from the Navy this year, Sir Ralph was Commander-in-Chief N.A.T.O. Naval Forces in the Mediterranean and Commander-in-Chief Mediterranean Fleet.

At Convocation at Oxford University last week, the Vice-Chancellor conferred the honorary degree of D.Sc. on **Mr. Ronald Holroyd,** a deputy chairman of Imperial Chemical Industries Limited.

Joint deputy managing director of the Power Gas Corporation, **Mr. R. W. Rutherford** has been appointed chairman of Nuclear Chemical Plant.

News from Vickers Limited is to the effect that **Sir Leslie Rowan,** K.C.B., C.V.O., and **Mr. R. P. H. Yapp** (who is a director of Vickers-Armstrongs Ltd.), have been appointed to the board of Vickers Ltd. Both these appointments will have effect as from December 8 next.

Lincoln works director of Smith's Stamping Works (Coventry), **Mr. H. M. H. Fox** has been re-elected to the board and appointed production director of the group.

Managing director of Vowles Aluminium Foundry Company Limited, **Mr. A. R. Ford** is leaving that company at the end of the year to join the Barton group of companies as managing director of the Premier Aluminium Casting Company Limited.

Finishing Supplement

Sprayed Electrolytic Zinc Coatings

By R. BOURCELOT

In this Paper, one of those presented a short time ago at the Second International Metal Spraying Conference, the author discusses the advantages of sprayed electrolytic zinc as a protective coating, in particular when a subsequent chemical or synthetic resin coating is applied.

OFTEN specifically called for by customers in tropical countries where the atmosphere is particularly corrosive and aggressive, is the process known as "tropicalization." In this process protection against corrosion is obtained by means of a protective film of electrolytic zinc, deposited with the aid of a spray gun, the as-sprayed coating being treated chemically for inhibition and to render it impermeable to liquids. To ensure this latter criterion, a supplementary coating based on synthetic resin is added in some cases.

Briefly, the conditions required for any metal coating are sound metal, on a suitably prepared sound base. In the case of zinc coatings, these conditions are achieved by the use of electrolytic zinc (99·99 per cent), with the basis metal prepared by sand blasting, preferably with alumina corundum.

Particular care in preparation is necessary in certain instances, e.g. lining plates assembled by riveting, weld seams, marine equipment which has been in contact with sea water, and forged parts which are scaled.

Coating Characteristics

For high-quality metal coatings, electrolytic zinc offers the following advantages:—its melting point is fairly low (420°C.); low hardness and good durability make it useful for building up; it has a high negative polarity for cathodic protection against corrosion, its e.m.f. being −1·1 V with respect to hydrogen; and zinc vapour has no toxic or noxious effects. Furthermore, some of the above factors render thin layers of zinc effective for protection against corrosion, so that the ratio weight of deposited metal:surface area of protected metal is small, for equal densities, all other factors remaining unchanged. Again, zinc has an acceptable appearance and is very amenable to chemical treatment, so that it is easy to produce a surface layer of stable salts.

Long service life in innumerable outdoor applications in the building industry has proved that although the metal does deteriorate under the effect of weather, its behaviour under thermal shock and in urban and industrial atmospheres is completely satisfactory.

Corrosion-resistant coatings are rarely required to help carry the mechanical stresses in the protected parts, except in the case of special coatings, such as stainless steel, which are intended to protect the piece against abrasion. The word "abrasion" is used deliberately, because friction and hammering (with a light mass and small kinetic energy) are sustained more easily by soft and ductile metals, such as zinc, than by hard metals.

The essential factor in the case of a corrosion-resistant sprayed electrolytic zinc coating is the high ductility of zinc, which enables it to locate itself in the most convenient position on the rough surface of the base metal and on the particles of zinc which have already been deposited.

Sprayed metal, unlike that which has been forged or rolled, possesses no directional properties, so that the coating has a very low coefficient of resilience and is, therefore, brittle. The brittleness of the sprayed coating will be the less, the greater the ductility of the base metal.

Electro-chemical corrosion effects, the Evans-effects, can be obviated by several methods, e.g. by having only one metal in the galvanic medium. This cannot normally be achieved particularly since in any given metal the adjacent molecules are of different polarity, which in an "adequate" electrolyte leads to corrosion. Another method is to immerse the article in a powerful dielectric to prevent exchange reactions in the electrolyte. Sooner or later, however, the dielectric will be punctured, due to capacity effects. Thirdly, the entire metal assembly can be passivated so that the surfaces in contact with the electrolyte have no polarity, and are thus maintained in neutral conditions.

By using a zinc coating, these three conditions can be achieved simultaneously. Thus, in the contact cells formed with the metals that are usually protected, namely, iron-zinc, copper (and its alloys)-zinc and aluminium-zinc, zinc has the lower negative polarity in each case. In the second instance, the metal to be protected is completely screened against the electrolyte by the Faraday cage formed by the impermeable coating. Finally, the zinc surface in contact with the electrolyte is passivated by it or preferably can be passivated by the deliberate formation of neutral salts such as zinc chromate, which prevent the formation of zincates of the general formula $Zn(OH)_n$ which dissolve in solutions with a pH of over 8·5, and by a sequence of chemical reactions wear away the coating.

If the electrolyte is weakly acid (pH>7), zinc coatings can be tropicalized by means of a screen of anti-acid dielectric synthetic resins, but these are not recommended for electrolytes with a pH of less than 7.

In the French Standard Specification PN.A 91-201, which lists zinc, aluminium and lead coatings, the recommended thicknesses for zinc are 40, 80, and 120μ, these being less than those specified for coatings of either lead or aluminium, all other conditions being equal.

Untreated sprayed zinc coatings are effective against chemical attack only in conditions where a pH greater than 7 is encountered. It is possible to inhibit a zinc surface, while it is in service, by occasional chemical treatment, or by a deliberate and controlled reaction (before or in service) to form stable salts which are precipitated in the capillary ducts of the coating and thus ensure that it is impermeable to liquids and that the surface in contact with any electrolyte which could cause electro-chemical corrosion has zero potential. It is always preferable to control these plugging and inhibiting reactions so that the conditions can be selected properly. Soluble compounds may be formed if the reactions take place in fluctuating conditions, with the result that, if the cycle is frequently repeated, the coating is completely removed.

A sprayed zinc coating has a very fine grain, and since only small thicknesses are required to achieve the desired properties, roughness is practically non-existent. After surface treatment, the coating will not show finger marks. Also, the greyish-blue appearance of old zinc and of galvanized articles is familiar to the eye and does not contrast with the colours of industrial equipment.

Chemical Treatment

In considering the need for supplementary treatment the following point is of particular importance, namely, the chemical activity of the zinc and the use to which the coating is to be put, especially the pH of the medium to which it will be subjected. Sprayed coatings are naturally porous, but the pores can be filled and the surfaces made impermeable to liquids by the deposition of thick coatings in successive layers. Even so, it is doubtful whether a degree of permeability suitable for a liquid with a low wetting ability is also suited for one with good

wetting properties. The coating may be rendered impermeable by immersion in a solution which produces coagulated precipitates that plug the pores. For this purpose, French Standard Specification PN.A 91-201 specifies a sodium chloride solution which forms zinc hypochlorite with the coating. The reaction, however, is easily reversible, and the product is hygroscopic. The action of chromic acid, with or without accelerator (dilute sulphuric acid) produces perfectly stable zinc chromates. The process is easily carried out and prevents the subsequent formation of zinc white. It has another advantage in that a chemical bridge is formed between the coating and any supplementary coat of paint. Also, chromates are excellent cathodic inhibitors.

Supplementary Coatings

A new technique is employed in France involving the use of anti-corrosion paints, which improve the cohesion of the metal coats, make the surface impermeable to liquids, and ensure that it is inert against various corrosive agents.

In the presence of aggressive elements it is necessary, in order to obtain a perfect coating, or as near perfect as possible, to improve the outer contact of the coating with the medium. This involves adding supplementary coatings of synthetic resins, carefully selected as regards their intrinsic behaviour to bases, alkalis, and acids; their bactericidal, fungicidal, anti-cryptogamic, etc., action; and their temperature range within which no deterioration takes place. In general, the resins employed are as follow:—styrene-butadene, with or without glycerophthalate, generally pigmented with zinc chromate, neutral or with benzoic acid as solvent and diluent; polyvinyl chlorides; glycerophthalates. All zinc-coated articles which do not come into contact with food stuffs, produced by the company with which the author is associated, are "tropicalized" with styrene-butadene, which is resistant to thermal shocks in the range −40°C.—180°C. and has bactericidal and anti-cryptogamic (fungicidal) properties. The supplementary treatment with synthetic resins increases the life of the coating quite considerably (on average, three times), according to experiments extending over twelve years, and they also act as a visible alarm signal indicating the deterioration of the coatings, thus facilitating maintenance work. They are cheap, and by giving the sprayed surfaces a uniform appearance they contribute to considerable economies in finishing coatings for decorative purposes.

As regards the actual spraying process itself, it should be noted that perfect adjustment of the supply of gas and air to the spray-guns is essential. Meters are necessary to reduce the loss of metal by vaporization (which may reach 30 per cent of the metal input) to a minimum. Among its disadvantages are the facts that the zinc dust, whose size ranges from 12-20μ, which is formed by condensation from the vapour, is very inflammable (comparable to magnesium), so that there is a certain danger of fire and large flooding installations are required, involving a considerable capital outlay on equipment which is also difficult to maintain. Another drawback is that it is difficult to regenerate the recovered zinc sludge or to sell it as a by-product.

An important feature as regards health hazards when spraying is that zinc vapour is non-toxic and non-noxious. Since, however, the vapour has irritating properties, it is essential to wear a mask which supplies air but leaves the sprayer quite free.

Bright Metal Coatings

DURING the course of the last decade or so, many of the well-known plating baths which have been used for the deposition of matte coatings have been replaced by baths formulated so as to produce bright deposits directly from the bath. The chief commercial advantages obtained by bright plating baths are: elimination of, or savings in, polishing time, and avoidance of metal losses in polishing, according to R. Weiner in an article in the German publication *Blech*.

It is, therefore, possible for the deposit, as plated, to be thinner and yet to obtain a final thickness equivalent to a thicker plating which has been subsequently polished down. Baths of very widely varying formulations may be employed for bright plating practice, the main differences being in the addition agents used to produce the brightening effect in the bath. A broad survey of the main characteristics on which bright bath compositions are formulated is given in Table I.

A characteristic feature is that bright baths generally work with a higher current density, so that from the quantitative point of view (see Table II) they are more productive than a matte working bath. The corrosion sensitivity of bright coatings is lower, and the hardness is usually greater than that of matte coatings. This increase in hardness can also, at times, be associated with a reduction of the resistance to scouring action (see Table III).

The conversion of existing matte plating processes to bright plating can frequently be conducted without any noteworthy difficulties, and, in a reasonably modern layout, there is no need for any considerable capital outlay.

When considering a change-over to bright plating processes, the technical

TABLE I—OPERATING CONDITIONS

Metal	Bath Type	Brightening Addition		Temperature °C.	Current Density Amp/dm²
		Inorganic	Organic		
Nickel	Sulphate	Zinc, cadmium, cobalt, boric acid	Sulpho-acids, nitrogen-containing sulpho-acids	40-70°	3-8
Copper	Cyanide	Selenium, cadmium	Sulphur- and nitrogen-containing compounds	60-100°	3-8
	Phosphoric Acid		Gelatine, thio-urea derivatives	30°	1·5-5
Zinc	Cyanide and Caustic Potash	Molybdenum, nickel, manganese	Aromatic aldehydes and ketones	25°	4-10
Cadmium	Cyanide	Nickel, molybdenum	Aromatic aldehydes and ketones	25°	4-10
Silver	Cyanide	Selenium, tellurium	Wetting agent	25°	1·5-3
	Cyanide	Antimony	Tartaric acid and alkali	25°	1-3
Gold	Cyanide	Phosphate	Condensation products of carbon bisulphide and acrolein	20-50°	0·3-2

TABLE II—PRODUCTION INCREASE IN BRIGHT PLATING BATHS

Metal	Type of Bath	Current density amp/dm²		Increase in Bath Load
		Normal bath	Bright bath	
Nickel	Sulphate	1	7	7
Copper	Cyanide	0·5	5	10
Zinc	Cyanide	1·5	8	5
Cadmium	Cyanide	1·5	8	5
Silver	Cyanide	0·5	2	4
Gold	Cyanide	0·3	2	6

TABLE III—CHARACTERISTICS OF MATTE AND BRIGHT COATINGS

Metal	Type of Bath		Vickers hardness at 10 microns diagonal impression kg/mm²	Scratch hardness at 10 microns scratch width kg/mm²	Scouring loss under the same conditions mg.	Potential shifting in bright bath
Nickel	Sulphate.	Normal	371	354	8	—
		Bright	622	433	16	—
Zinc	Cyanide.	Normal	111	128	20	
		Bright	148	186	6	+
Cadmium	Cyanide.	Normal	46	67	14	
		Bright	45	62	28	—
Copper	Cyanide.	Normal	222	222	20	
		Bright	236	225	17	0
Silver	Cyanide.	Normal	124	105	20	
		Bright (Selenium)	88	105	22	+
		Bright (Antimony)	157	131	22	—

advantages of anodic polishing (electropolishing) should not be overlooked. This process may be applied to the pretreatment of work passing to the bright plating baths, and intermediate (inter-stage) electropolishing can also be practised during the deposition of multi-coat bright plate.

Plastics Plating Barrel

MADE from ½ in. thick specially treated, abrasion - resistant "Perspex," assembled by means of Nylon screws, a totally immersed hexagonal plating barrel, the EPE24, has just been introduced by Sonic Engineering and Equipment Limited, 120-130 Parchmore Road, Thornton Heath, Surrey. The bearings and the intermediate drive gears for rotating the barrel are of resin-laminated fabric, and the insulated tie rods are the only steel parts employed, so that the barrel is resistant to all types of pre-cleaning and plating solutions at all operating temperatures, and can thus be used effectively throughout the entire cleaning and plating cycle, thereby eliminating a great deal of handling. Since no cement or doughing is used in manufacture, the replacement of any part is a simple process as compared with conventional barrels, where the replacement of a damaged panel, for example, is often a major operation.

A quick release lid is fitted to the barrel for loading and unloading, and the perforations in the panels are made to suit the type of part to be plated. The model illustrated has a central partition to enable different sizes of parts to be plated at the same time, and the suspension arrangements can be modified to suit individual requirements. The overall length of this model is 24 in. and the diameter across the flats is 14½ in., giving a process load of up to 90 lb. The hangers are rubber covered so that no deposit build-up can take place. Barrel units can be supplied individually or with whatever types of tank and drive unit are required, such as individual plating units or complete cleaning, plating and rinsing units for large-scale production.

The EPE 24 totally immersed Perspex plating barrel introduced by Sonic Engineering and Equipment Limited

Parts which can be successfully plated in this type of barrel include safety pins, rivets, nails, all types of screws, bolts, nuts, washers, and small automobile and aircraft components. In particular, many types of article which, because of their size, would normally have to be jigged and vat plated can be processed.

Suppressing Spray

RECENT investigations have shown that considerable improvement in the outdoor corrosion resistance of chromium plated fine-grained bright nickel deposits can be obtained by operating the chromium plating bath at higher temperatures (130°F.) and higher ratios of chromic acid to sulphate (200:1) to give thicker deposits (0·05 mil to 0·08 mil), and it is likely that these baths will have important applications in the motor industry. Zero-Mist HT-2, a new product of Electro-Chemical Engineering Co. Ltd., is particularly suitable for use with higher temperature baths. It is supplied in tablet form in two colours—green for the initial addition to the extent of 6 lb/1,000 gal., and off-white for maintenance additions.

The only requirement for the suppression of mist and spray (which increase plant corrosion, bath losses and contamination of adjacent baths) is to have a sufficient concentration of Zero-Mist HT-2 present in the chromium plating solution to maintain a thin film of foam during plating. This thin film of foam must be maintained by observation of the foam and by adding Zero-Mist HT-2 maintenance tablets as required. If desired, the surface tension of the solution (preferably 35 to 40 dynes/cm.) may be determined by a simple stalagmometer method.

Maintenance tablet additions will naturally vary from one installation to another, depending on the amount of dragout, but are expected to be of the order of 8 oz/1,000 gal/week for an average installation. Frequent small additions are preferable to larger ones at greater time intervals.

Zirconium Determinations

DESCRIBING the use of *p*-bromomandelic acid as a reagent for zirconium, a further booklet in the series "Organic Chemical Reagents" has been issued by Hopkin and Williams Ltd., of Chadwell Heath, Essex. Gravimetric methods of determination are discussed, and a recommended procedure is described, the influence of various added ions being reported. Other methods of determination are briefly outlined.

Atomic Progress

Fuel Element Behaviour

IN the development of nuclear power programmes, the behaviour of fuel elements under irradiation is of major importance. It is essential that fuel elements achieve high irradiation levels, i.e. burn-ups, without failure. This is more likely if only small dimensional and metallurgical changes take place during the irradiation. Both at Windscale and at Calder the vast majority of fuel elements have performed their task satisfactorily. Some failures have occurred, and attention has been concentrated on these or on features discovered in sound fuel elements which might subsequently have led to failure. The Geneva conference Paper "Fuel Element Behaviour Under Irradiation," by V. W. Eldred, G. B. Greenough and P. Leech, describes some of the scientifically interesting observations on Windscale and Calder Hall fuel elements.

In the Windscale fuel elements, natural uranium fuel is contained in longitudinally finned high-purity aluminium cans. These are supported on graphite boats, which rest in horizontal channels through the graphite moderator. The reactors are air-cooled.

Surface Wrinkling

The surfaces of early fuel elements, in which the fuel rod was machined from cast uranium, were found to have an irregular wrinkled appearance after irradiation. Large numbers of fuel elements were radiographed with the object of correlating the degree of surface wrinkling with irradiation conditions. To facilitate assessment, the authors defined a "wrinkling parameter," which was obtained by measuring, on the radiographs, the diameter of the bar at one centimetre intervals along its length and summing the deviations from the mean diameter, irrespective of sign. Low numbers, less than 3, indicate slight wrinkling, and high numbers, greater than 9, represent very severe wrinkling. The authors use this parameter to demonstrate clearly that the development of surface wrinkles is most serious in the temperature range between 150° and 200°C. At temperatures above 350°C. they state that wrinkling does not appear to be a problem.

The explanation of wrinkling is found in the anisotropic behaviour of uranium. Under irradiation, single crystals of uranium increase in length in (010) directions, contract along (100) directions, and remain unchanged along (001) directions. A dependence on grain size is naturally expected, and was well demonstrated in some fuel elements containing beta-quenched uranium. This heat-treatment had not completely refined the grain size. Sectioning through the bars showed large grain sizes where most wrinkling had occurred, and fine grain sizes elsewhere. Clearly a fine grain size, such as is obtained on quenching from the beta phase, provides a cure for wrinkling. At first it was thought that a narrow rim of fine grains at the surface of the bar would be sufficient, but the authors show a photograph of a large wrinkle caused by a large grain situated below the surface.

Although wrinkling is clearly the result of irradiation growth, precise interpretations are not advanced. The observation that wrinkling is a maximum at 150°-200°C. could be explained if the irradiation growth rate is also a maximum at these temperatures, equally it could be due to a change in deformation mechanism (twinning is most pronounced in the range 150°-200°C.).

The authors report increases in the hardness of uranium as a result of irradiation at temperatures of 150°-300°C., associated with an increase in the U.T.S. and a decrease in ductility.

Density Change

An average decrease in density of 0·7 per cent is reported by the authors for Windscale fuel for a mean irradiation level and temperature of 1,000 MWD/tonne and 220°C. respectively. The decrease in density was most marked in the range 150°-200°C. The authors state that sufficient holes, between about 10^{-2} and 10^{-4} mm^2, in cross-section, were detected in the fuel, to account for the density change after allowance had been made for the effect of fission products in solid solution. The holes were frequently associated with inclusions, especially those in the form of flakes or stringers. The authors believe the development of such holes in this temperature range is related to the phenomenon of irradiation growth, and it is quite distinct from the swelling which occurs at high temperatures.

In general, cast and machined uranium fuel rods have changed in length by less than 1 per cent for an irradiation level of 1,000 MWD/tonne.

Can Behaviour

The high-purity aluminium Windscale cans do not reveal any changes in microstructure as a result of irradiation, in spite of severe distortion due to wrinkling. The authors note that there is some evidence of an increase in hardness in material irradiated below 100°C.

Fuel Element Failures

Less than 0·1 per cent of the total number of Windscale fuel elements have failed. Those which have been examined fall into definite types, which are described by the authors.

On detection of a failure, the whole channel of fuel elements concerned is discharged. The actual element which has failed is determined by immersion of each element in turn in 50 per cent nitric acid for 10 min., after which the acid is monitored for activity. Only fuel elements in which the uranium is exposed to the acid give an appreciable signal.

One group of failures arose due to wrinkles on the ends of bars. If large enough, the wrinkles pushed the end cap off the can. Bar length increases of up to 0·3 in. have been recorded with this type of failure.

The second group of failures described by the authors arose from thinning of the can wall near the end cap during manufacture of one batch of cartridges. Small strains arising during reactor operation were then sufficient to cause fracture after relatively short irradiation periods.

Interdiffusion of uranium and aluminium, with the formation of the intermetallic compound UAl_3, led to a third group of failures. During manufacture of these fuel elements, the inside of the can and the surface of the bar are coated with a separating medium to prevent interaction between the two. A break in this interlayer, either during manufacture or during irradiation, may lead to the formation of UAl_3. The authors state that the volume increase associated with the formation of this phase, and its brittle nature, can easily cause failure of the can wall. The compound has been identified using X-ray crystallographic and metallographic techniques. Failures of this type, the authors explain, are always associated with fuel elements operating in the reactor where the can temperatures were highest. This is as expected, since the rate of penetration of the can is diffusion controlled.

The final type of failure was related to one batch of cartridges made by one particular manufacturing technique. A small dimensional increase occurred in the fuel due to irradiation growth and, because of a local weakness in the cans, the whole of the dimensional change was taken up at one place near one end of the can, causing rupture at that point.

It cannot be over-emphasized that work on irradiated fuel elements requires much patience and initiative, and the authors conclude with a tribute to many of their colleagues who obtained many of the results.

The results of the work on Calder fuel elements will be described in a future article.

References

1 "Fuel Element Behaviour Under Irradiation," by V. W. Eldred, G. B Greenough, and P. Leech. A/Conf. 15/P/50.

Reviews of the Month

NEW BOOKS AND THEIR AUTHORS

ORGANIC FINISHING

"Paint Finishing in Industry." *By A. A. B. Harvey. Published by Robert Draper Ltd., Kerbihan House, 85 Udney Park Road, Teddington, Middlesex. Pp. xvi* + 488. *Price* 84*s.* 0*d.* ($12.00).

THE author of this excellent volume offers excuses in his preface, without any necessity whatever, for its preparation; his main excuse is that the subject matter of his book has not been dealt with comprehensively during the past ten years. During the period in question there has been a virtual revolution in organic finishing, certainly in the motor industry, with which the author is particularly familiar; the period has seen the general adoption of phosphate pretreatment for motor car body shells, the development and introduction of both mechanical and electrostatic automatic painting systems, and very considerable modifications and developments in the formulation of the various organic finishes used. An apology might have been expected of the author that he has covered so much ground in a single volume, but he has, nevertheless, achieved this in a most satisfactory manner.

This book should find a place on the desk of all executives dealing with organic finishing, and on the work bench of many of our technicians and technologists. It comprises a ready reference on most aspects of paint finishing that can be possibly imagined, ranging from preparation for painting of metallic and non-metallic surfaces to methods of testing the resultant finish. Detailed information is given on pretreatment procedures which may be necessary, the various methods of applying paint, workshop procedures, methods of testing the materials used both in the wet state and as dried films, and a description of troubles associated with the application of organic finishes and during subsequent service.

To those with particularly enquiring minds, there is a serious omission in that no logical explanation is given for some of the troubles to which reference is made, and to service faults which are discussed, and it is to be hoped that someone associated with the paint manufacturing industry may be sufficiently forthcoming to produce a companion volume dealing in full detail with all the faults likely to occur in industrial finishing, both during application and in service; such a volume should provide information not only on tried and established methods for overcoming at least some of the troubles, but a logical explanation for each and every one. Perhaps this is far too much to expect of any one individual, and for that reason it is to be hoped that Mr. Harvey might be persuaded to join forces with one of his many friends in the paint industry to produce such a companion volume.

The terse dismissal by the author of the subject of effluent disposal implies a very considerable knowledge of the subject on his part; this is a problem which is causing grave concern to industry in general, and very wisely the author has seen fit to direct the attention of the reader to the help which can be obtained from the D.S.I.R.

Each chapter of this book is provided with a series of most useful references to the subject matter discussed, and liberal use is made of illustrations covering all aspects of organic finishing. The final sections comprise an index of related specifications, together with a tabulation of the properties of solvents in common use.

R. J. B.

BINARY ALLOYS

"Constitution of Binary Alloys." *Second Edition. By Max Hansen and Kurt Anderko. Published by McGraw-Hill Publishing Co. Ltd., 95 Farringdon Street, London, E.C.*4. *Pp. xix* + 1305. *Price* £12 12*s.* 0*d.*

THE first edition of this well-known book appeared in 1936, and comprised 1100 pages. It was for many years a standard source of reference, but had become increasingly out of date, and the appearance of the second edition has been eagerly awaited. In spite of the large amount of new work, the present volume occupies only 1286 pages, including an appendix of 21 pages with tables of physical properties of the elements, structural data, crystal structure types, temperature conversions, and interconversion of atomic and weight percentages. This has been done without any loss of essential data, and is a remarkable achievement. Some of this abbreviation has been achieved by the omission of names from the text, so that one reads, for example, that the liquidus of a particular system was determined by (4), whose work disproved the supposed diagram of (1) and (3)—the names are then given in the list of references at the end of the section dealing with the system concerned. On the whole, the method justifies itself, although the wear and tear of the pages will be increased.

The writing of the book is excellent, and the diagrams are admirable. It is a sign of the advances in metallurgical science that they are now drawn in atomic percentages, with an auxiliary scale of weight percentages. The temperatures of horizontals, and of the maxima and minima in liquidus curves are indicated clearly on the diagrams, and also the compositions of critical points such as eutectics, eutectoids, maximum solid solubilities, etc. The diagrams are, indeed, as helpful as anything could be on the scale of a book with pages 9 in × 6 in. In each system, the crystal structures and lattice spacings of intermediate phases are given, together with references to work on the variation of lattice spacing with composition where this is available.

When compared with the first edition, much more attempt has been made to unite the work of different investigators in order to give the most probable diagram, and the reader is given more help in judging the accuracy of the work. The reviewer has noticed occasional misprints in the references, but these are rare. The book can be wholeheartedly recommended, provided that the reader realizes that, where the details of a diagram are of critical importance, it is generally necessary to consult the original Papers in order to see exactly what was established.

Having produced such an admirable book, it is to be hoped that the authors will arrange for it to be brought up to date at reasonable intervals. The publication of short supplementary volumes every three or four years would be of great value to those whose work requires a knowledge of binary metallic systems.

W. H.-R.

SURFACE PHENOMENA

"Effect of Surface on the Behaviour of Metals." *Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.*1. *Pp.* 100. *Price* 21*s.* 0*d.*

THIS is another volume in the very useful series based on the lectures given at the Institution of Metallurgists' Refresher Courses. The four articles are all the more readable for being reprinted lectures.

The first, by Dr. G. L. J. Bailey, is on methods of preparation and examination of surfaces. It discusses, briefly, a number of methods, with particular emphasis on electron microscopic and electron diffraction techniques.

The second Paper, by Dr. T. P. Hoar, outlines the effect of surface treatments on the chemical behaviour of metals. This gives a succinct account of the electrochemistry of metal surfaces, and the oxide layers which can be produced on them, with a very brief look at the principles of temporary surface protection by organic compounds.

Dr. F. T. Barwell gives a rather

more detailed treatment of the relationships between surface condition, friction and wear, with particular reference to bearings.

In the final Paper on properties of metals, Dr. R. W. B. Stevens rapidly surveys a wide range of physical properties, including optical, thermal, electrical, and magnetic phenomena.

The book, as a whole, gives a quick survey of a large range of surface phenomena, with little attention to the points of detail. As such, it is of little use to the specialist in this field. However, as the title of the series suggests, it is a good refresher for general reading by metallurgists. It may also help to focus attention on a number of aspects of metallurgy which do not always receive the attention they deserve.

D. W. W.

INDUSTRIAL DEVELOPMENT

"The Structure of British Industry." *Vol. 2. Edited by Duncan Burn. Published by Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1. Pp. xii + 499. Price 50s. 0d.*

AS a background to the activities of individual firms or, for that matter, of individuals, this survey of the history, development and current status of some of the major branches of British industry makes interesting reading. It is published as No. XV in the series of Economic and Social Studies prepared by the National Institute of Economic and Social Research, and it is from the economic or sociological viewpoint that the book will be deemed most valuable.

In outlining the development of the motor industry, for example, it emphasizes the multiplicity of firms engaged in car manufacture at the beginning of the century, and points out the important part played by the introduction of standardized components. Similarly, price competition is studied briefly against product competition (improvements in style or efficiency) and, presenting a brief though limited picture of the economics of the industry, the book provides food for thought for the layman as well as the specialist.

Each of the industries dealt with is approached in a broadly similar way: its development and production and those factors that affect them are discussed, together with markets, competition, monopolies, and allied topics. The industries dealt with in this, Volume II, are the motor industry, the aircraft industry, the shipbuilding industry, the electronics industry, the cotton and rayon textile industry, the woollen and worsted industry, the man-made fibres industry, the pottery industry, the pharmaceutical industry, and the cutlery trade.

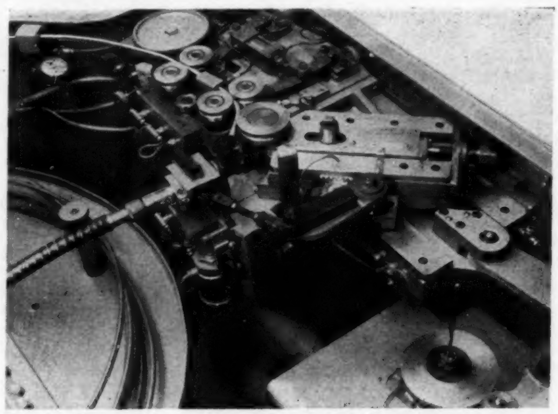
In a final section, entitled "Retrospect," the editor discusses the influence of the particular period in history on the economist's view of industry, and also the effects of social and other changes. He also comments on the criteria used by the various contributors to the volume, reviews competition and incentives, finance and investment, and deals with the impact of State intervention.

Coiling Copper Tube

HANDLING and transport of straight lengths of copper tubing have presented many problems in the past, and the "Skinner" copper tube coiling machine, introduced by Stanley Howard Ltd., 73 Devon Street, Saltley, Birmingham, 7 (sole distributors), has been specially designed to coil copper tubes with outside diameters from $\frac{5}{8}$ in. to $1\frac{3}{8}$ in. Four adjustable feed rollers and one bending roller are controlled by a cam.

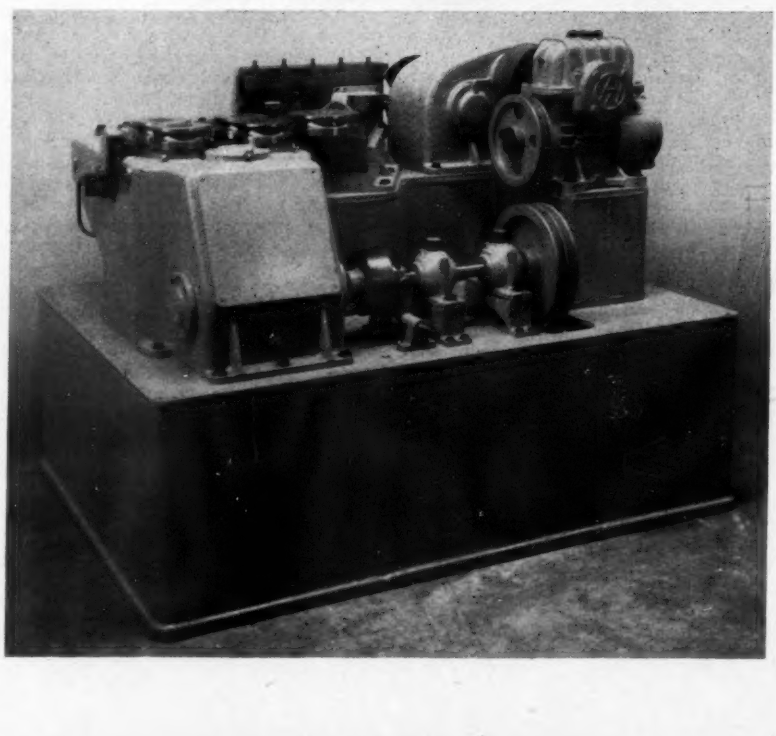
The machine, which is of the fixed tray type, is quite simple to operate:—The controlling mechanism is set at the start position, this being indicated by a green light. The copper tube is introduced to the feeding bush by the operator, where it is picked up by the feed rollers. When leaving the feed roller, the tube is bent by a roller which is designed to create the required diameter of the roll, which has been predetermined. The machine can easily be adjusted to vary the diameter of coil.

If a flat (pancake) coil is required, the bending roller is moved by a cam action which provides a diminishing radius resulting in the tube coiling within itself. Drive is by a 15 h.p. motor, and the machine occupies a floor space of only 4 ft. 11 in. by 4 ft. 5 in.



Right: Close-up view of the small copper tube coiling machine showing rising saw cut-off mechanism

Below: Large tube coiling machine with guards and covers removed



Industrial News — *Home and Overseas*

Engineering Scholarship Scheme

A scheme of university scholarship awards, up to three in any year, has just been announced by the **Birfield Group** to commence next year. By means of this scheme, young men will be given the benefits of a residential university in conjunction with the necessary practical training and experience in a position of responsibility.

Applications are invited from young men whose academic qualifications will admit them to the honours degree course of the engineering faculty of a British university, and who have taken steps to obtain a place at a university. Full details of the scheme and application forms may be obtained from the Warden, Birfield Group Conference Centre, Goldicote House, Stratford-upon-Avon.

Metal Finishing

On Thursday, December 18 next, the traditional stag party of the Midland Branch of the **Institute of Metal Finishing** will, this year, take the form of a "Christmas Depositors' Do," and will be held at the White Horse Hotel, Congreve Street, Birmingham. Tickets for this event, price 15s. each, may be obtained from Mr. C. R. Darby, 1 Calverley Road, Kings Norton, Birmingham, 30.

New Offices

Additional premises have been acquired by **Sintering and Brazing Furnaces Ltd.**, and offices have now been established at 124a/130 Edinburgh Avenue, Trading Estate, Slough, Bucks., with the telephone numbers of Slough 21143 and 24011. All future communications should be sent to the company at their new office address.

Automatic Spraying Machine

A pneumatically-operated paint sprayer, capable of spraying 120 oil drums an hour, has been installed at the Wandsworth works of the Mobil Oil Company Ltd. This spraying machine is stated to save both paint and labour. It has been designed by **The Hymatic Engineering Company Ltd.**, in association with **Alfred Bullows and Sons Ltd.**

Pressing Lubricant

It is reported that "Gredag" molybdenum disulphide grease (Grade MP30) has been adopted as a titanium pressing lubricant by The de Havilland Aircraft Company Ltd., following tests made by their production research department. "Gredag" is one of the products of **Acheson Colloids Ltd.**

Finnish Copper Find

Recent news from Helsinki states that the Finnish company, Ruskealan Marmori Oy, has discovered an ore bed estimated to contain 2,000,000 metric tons of material assaying 1·5 per cent copper and 1 per cent zinc. It also holds appreciable amounts of silver and nickel. The company has decided to exploit the deposit and to erect a concentrating plant in the area. The products of this plant will be sent for smelting to Juankoski or Sysmajarvi.

Aluminium Alloys Patent

A patent has been granted to **John Ireland (Wolverhampton) Ltd.**, in the names of J. R. Ireland and A. Hazell, for specification of an alloy which can be pressure die-cast by normal methods but which can be polished and self or colour anodized.

The complete specification gives details of the several elements included in the alloy, and some notes on the casting technique. The company produces many thousands of castings in the alloy for the building trades, and other applications are arising where finish and protection are important.

Exhibition at Cranfield

More than 2,000 people attended a four-day exhibition devoted to the latest developments and uses of nickel, held last week at the College of Aeronautics, Cranfield. The exhibition was organized by **The Mond Nickel Co. Ltd.**, in co-operation with the College, and included a number of striking working demonstrations of the wide application of these materials in all branches of industry.

A particular feature of the week was a lecture symposium, organized by the Department of Aircraft Materials of the college, and attended by 200 specially invited representatives from the aircraft industry, as well as by several hundred people from educational and industrial establishments. The lectures were concerned particularly with the application of nickel alloys in aircraft engineering. At the lunch organized for the occasion, Prof. A. D. Baxter, a former Professor of Aircraft Propulsion at the college, and now a director of the de Havilland Engine Co. Ltd., welcomed the meeting as a sign of the growing activity of the new materials department, and of the excellent and extensive co-operation it has received from The Mond Nickel Co. Ltd.

Indian Import Licences

It has been announced in Bombay that import licences for copper and zinc ingots under the Government's export promotion scheme are to be issued against exports to registered manufacturers of semis and registered makers of utensils, artware, and similar products. Import licences will be issued to manufacturers of semis against receipt of firm foreign orders valued at 200,000 rupees at least.

Manufacturers of utensils and other products will get their import licences only if supplies of semis cannot be released from the manufacturers. The import licence or release order will be issued against firm foreign orders valued at at least 20,000 rupees.

World Tin

Statistics issued by the International Tin Council reports that mine production of tin-in-concentrates in Indonesia increased in October to 2,622 tons. Production in Nigeria during September was 498 tons, slightly less than in August.

Exports of tin-in-concentrates from Indonesia increased further in September to 2,189 tons. Exports from Bolivia during September recovered sharply to 2,222 tons. In June, exports from the Belgian Congo amounted to 527 tons.

Imports of tin-in-concentrates into the Netherlands rose sharply in September to 2,173 tons. During October, imports into the United Kingdom increased to 1,913 tons. Only 45 tons of tin-in-concentrates were imported into the U.S. in July.

Smelter production of tin metal in Singapore and the Federation of Malaya was again lower in September, amounting to only 2,859 tons. Output in United Kingdom smelters in October (2,488 tons) was at much the same level as in the previous two months.

Exports of tin metal from the Federation of Malaya and Singapore recovered in October to 3,563 tons. During September, exports of metal from the United Kingdom (838 tons) were little changed from the previous month, but exports from the Netherlands rose appreciably to 2,827 tons. Exports from the Belgian Congo during June were 231 tons.

Imports of tin metal declined in September in the United Kingdom (1,141 tons), France (716 tons) and Denmark (235 tons). On the other hand, imports into the Netherlands, which had amounted to only 114 tons in August, rose to 1,500 tons in September.

Stocks in the Federation of Malaya and Singapore were higher at the end of September—7,966 tons of tin-in-concentrates and 2,403 tons of metal. Stocks of tin-in-concentrates at United Kingdom smelters declined at the end of October to 1,419 tons, but stocks of metal increased to 1,246 tons. Stocks of tin metal in official warehouses in the United Kingdom totalled 17,627 tons at the end of October.

Production of tinplate in the U.S. rose substantially in September to 507,996 tons. Output in the United Kingdom increased to 87,000 tons in August, but fell steeply in September to 60,300 tons. Production in Japan fell in August to 18,671 tons. During October, production in the Netherlands was again high (9,842 tons). In September, output in Italy rose to 11,357 tons.

Aluminium Canada House

A new office building of seven storeys recently completed in Berkeley Square, London, is under long lease to **Aluminium (Canada) Limited,** London correspondent of the world-wide Aluminium Limited group of companies. The choice of aluminium, which is used for some noteworthy details, is well justified in the striking manner in which the metal has been integrated into the general design of the building.

Exterior evidence of the use of aluminium can be seen in the windows, manufactured by Williams and Williams Ltd., which throughout are of Noral 50S alloy (B.S.1476:H9), anodized to give a surface coating 0·001 in. thick; the metal for the windows and for all other aluminium work in the building was supplied by **Northern Aluminium Company Ltd.** To the passer-by the most striking example of the use of aluminium is undoubtedly the massive main doors, which are faced with satin-anodized aluminium sheet. Each leaf bears eight rectangular panels made up of Noral 50S extruded sections; one panel on each door carries a large door-pull, while each of the others bears an anodized maple-leaf, symbolic of the association

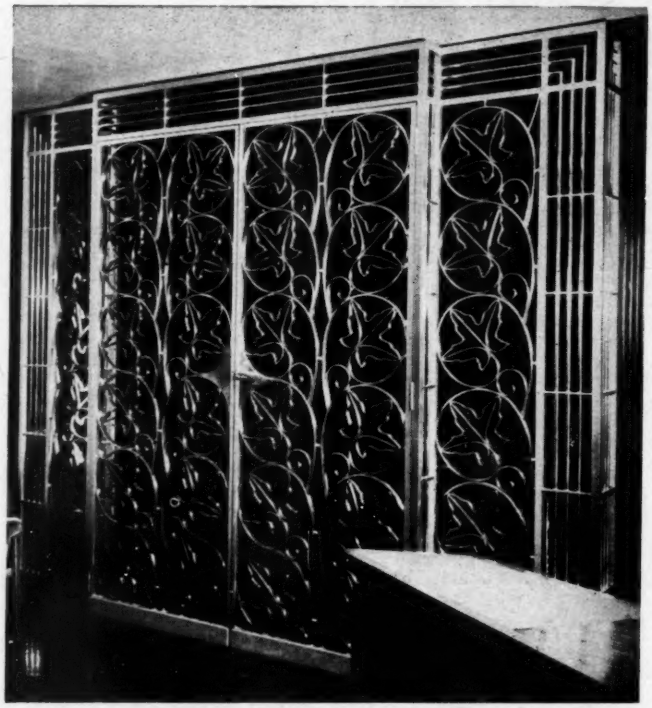
with Canada, cast in Noral 100 alloy. The aluminium cladding of the doors—the overall sheet, the inset panels and their castings — has been assembled entirely without visible fastenings, giving a smooth, unbroken exterior finish. The doors were constructed by Culford Art Metal Company, who also fabricated the associated aluminium work at the entrances and the balustrades of the main staircases. Above the doors, a grille of Noral 2S (B.S.1476:E1C) extruded sections provides a decorative effect in front of a fanlight of ½ in. plate glass.

Inner doors of armourplate glass, with aluminium furniture and framing details, lead into the main entrance hall. Here, aluminium has been used for acoustic ceiling tiles, for radiator grilles and floor inlays. The two passenger lifts at the rear of the entrance hall are finished entirely in aluminium, and in these the value of anodizing can be appreciated. Any over-metallic interior effect has been avoided by satin-anodizing, giving a hard-wearing, lustrous, silvery sheen.

The main staircase in the building makes use of a pleasing blend of finishes; the balustrade has a handrail of anodized aluminium extruded section; the standards are constructed in cellulosed mild steel rod with aluminium ferrules, every ninth standard being of aluminium; the top and bottom rails are of cellulosed flat steel bar.

The decor of the fourth and fifth floors is quite outstanding in conception, considerable quantities of anodized aluminium being used with a restraint that gives an effect of quiet luxury. The foyer providing access to the suite is panelled in walnut, and is divided from the elevator landing by an aluminium-framed glass screen. On the far wall, as seen from the lifts, a striking wrought aluminium grille stands before the windows; this again carries the maple-leaf motif. At one side of the foyer are three illuminated recesses containing symbolic representations of the Arts, Engineering and Transport. The metalwork incorporated in these decorations and elsewhere in the suite was fabricated by J. Starkie Gardner Limited.

The offices generally are on the main elevations, and are served by corridors that are notably spacious. The corridor walls are partly aluminium-clad, using an extruded fascia section in Noral 50S alloy; an extruded section is also used to face the square corridor stanchions. The board room is panelled in walnut on three sides, one of which carries an anodized outline map of the world cut out from aluminium plate. Aluminium glazed doors set in an aluminium screen give access to the library, and the secretaries' office opposite is separated from the corridor by another large aluminium-framed glass partition.



The aluminium grille shown in the above photograph is a striking feature of the suite occupied by Aluminium (Canada) Limited in the recently-completed Aluminium Canada House in London

Contracts Received

First part of a large order covering the supply of vehicle battery charging equipment in the new assembly building for the Ford Motor Company at Dagenham, has been secured by the Rectifier Division of **Westinghouse Brake and Signal Company Ltd.** These chargers are of proven design and incorporate means of automatic charge termination.

Modernization work by the Cork Corporation in Eire has resulted in the company also securing the order for the supply of vehicle battery charging equipment through Murphy Electric Company. These equipments, while following the familiar design and features of the VZ range of Westalite chargers, include several special features which the customer requested.

Physical Society Exhibition

From January 19 to 22, 1959, the **Physical Society** will hold its annual exhibition in the Old and New Halls of the Royal Horticultural Society, Westminster, London. This exhibition, which is the 43rd of the series, will include 153 exhibitors, and will represent a cross-section of the latest developments in British physics.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of the week to November 24 totalled 17,393 tons, comprising London 6,040; Liverpool, 9,848; and Hull, 1505 tons. A week before, the overall figure was 17,282 tons — London 6,050; Liverpool 9,727, and Hull 1,505 tons.

Copper stocks totalled 6,221 tons, and comprised — London 4,500; Liverpool 1,446; Birmingham 25; Manchester 250 tons, and Swansea nil. In the week to November 15, the total was 6,096 tons—London 4,375; Liverpool 1,446; Birmingham 25; Manchester 250 tons, and Swansea nil.

Change of Venue

Owing to the unprecedentedly large number of applications received for the sessions on continuous casting on December 10, which form part of the Autumn Meeting of the **Iron and Steel Institute,** and also for the 38th meeting of the Engineers' Group, on vacuum processes, to be held the following day, it has been decided to hold these meetings at Caxton Hall, Caxton Street, London, S.W.1, instead of at the offices of the institute, as originally arranged.

The technical sessions on creep and on hydrogen in weld metal will be held at the Institution of Naval Architects as originally announced.

Copper Roofing

On his recent return to this country, the building engineer of the **Copper Development Association,** Dr. E. Carr, Ph.D., B.Sc., had completed an itinerary involving large areas of Northern and Southern Rhodesia, together with several places in the Union of South Africa. The primary object of his visit was to investigate the use of copper for building purposes within these localities. Whilst obtaining a comprehensive appreciation of prevailing African conditions, Dr. Carr was at the same time able to advise architects, local authorities, builders and fabricators on many subjects appertaining to the employment of copper.

To meet the shortage of skilled labour generally prevailing throughout Africa, a new type of prefabricated copper roofing has been developed by the C.D.A. building department during the last twelve months. This has aroused considerable interest and was discussed with architects, public works department officials, and contractors.

It has now been decided to form an independent C.D.A. in the Central African Federation in order to further the use of copper and its alloys by African industries. During the course of his tour, Dr. Carr was able to assist and advise on the establishment of such an organization.

Business Appointments

Among appointments recently announced by the **Firth Cleveland Group** is that of Mr. F. A. Field as general sales manager to Firth Cleveland Tools Ltd., of Tipton. Export appointments within Landmaster Ltd. are those of Mr. J. H. Smeddle and Mr. M. M. Monfort as export executives, while Mr. T. Rennison, formerly shipping manager, has been

appointed commercial manager (export).

Steels Engineering Products Ltd., of Sunderland, who design, manufacture and market Coles cranes, have appointed Mr. C. E. Drew as an overseas sales executive. He will be attached to the export sales department at the company's London offices.

Electronic Computers

A most comprehensive exhibition of electronic computers opens this morning (November 28) at Olympia, London, and will show significant trends in computer design. The exhibition will remain open until the evening of December 4, and in conjunction with this event a Business Computer Symposium is being held for three days—December 1, 2 and 3.

The Symposium, consisting of some 24 Papers by users of computers, will embrace all types of computers in all types of business; the Papers will deal with practical experience covering initial feasibility studies and subsequent investigation by organization computer study groups, installation training, the results obtained, and the further results which can be foreseen.

Technical Abstracts

For some time it has been recognized by the **Lead Development Association** that its services should include the assembly, co-ordination and dissemination of relevant information from current literature on lead, and to this end the association has published the first issue of a new publication under the title of "Technical Abstracts," in which such information is given in digest form.

A second section of the publication sets out brief information on new patents which have come to the notice of the association. It is proposed that future editions of this publication should be issued quarterly.

Prevention of Corrosion

Once again the Corrosion Group of the **Society of Chemical Industry** is organizing an exhibition relating to prevention of metallic corrosion, to be held at the Battersea College of Technology, London, on Thursday and Friday, January 22 and 23, 1959. The main theme of the exhibition is the apparatus and techniques used for research and for control of anti-corrosion processes, but recent developments in other fields will be shown.

Foundry Apprentice Contests

Early entries for the American Foundrymen's Society sponsored apprentice contests suggests that the record of 600 entries in the 1958 competitions will be far surpassed in the coming year. So far the advanced entries for 1959 total 216.

The society, under the direction of its education division, assumes responsibility for the administration of the contest and supplies the necessary materials for local elimination contests, and the national judging. From the beginning of these contests in 1924, top management in the metals field in the U.S.A. has recognized the training opportunities that these industry-wide competitions offer to their own personnel.

South African Customs Duties

In a recent issue of the South African Government Gazette it was stated that the Union Board of Trade and Industries have received the following representations affecting the Union's Customs Tariff: For an increase of duty on the following materials from free of duty to 15 per cent *ad valorem*:—

(A) Aluminium sheet in all alloys except those containing any of the following alloying constituents in excess of the amounts indicated: 0·4 per cent magnesium, 0·5 per cent copper, 1 per cent silicon, in the following forms—(a) Flat sheets in widths up to and including 64 in. and in thicknesses from 0·012 in. up to and including 0·125 in. (b) Roofing and siding sheets in corrugated or other formed configuration in widths up to and including 30 in. and lengths up to and including 12 ft. and in all thicknesses. (c) Coiled sheet in widths up to and including 33 in. and in all thicknesses up to and including 0·125 in. to be used for all purposes other than re-rolling to foil (coiled sheet for re-rolling to foil is usually known as "foilstock"). (d) Sheet circles in diameters up to and including 48 in. and in all thicknesses up to and including 0·25 in.

(B) Aluminium foil (less than 0·006 in. thick) containing less than 97·5 per cent aluminium in coils, reels, circles, or rectangles, either plain, clear lacquered or overall colour lacquered.

(C) Aluminium extruded sections and tubing in all alloys except those containing any of the following alloying constituents in excess of the amounts indicated: 4 per cent magnesium, 0·5 per cent copper, 2 per cent silicon, 0·5 per cent zinc, in the following forms—(a) Solid extruded sections and bar up to and including 9⅝ in. width; (b) hollow extruded sections up to and including 6 in. width; (c) extruded rod up to and including 6 in. diameter; (d) tubing between ½ in. and 4½ in. outside diameter, both figures inclusive.

Platinum Price Cut

Effective on Tuesday last (November 25), Baker Platinum and Johnson Matthey, the two leading refiners of platinum, in the United Kingdom, are reducing the price of platinum to their regular customers to £19½ per troy ounce from £21½, which price has been in force since September 22. These companies reduced their price in the United States by a similar amount at the end of last week.

The unsettled state of the market has been underlined for a long time past by the discounts obtainable in the free market, where prices recently were indicated at £18½ to £19 per troy ounce, trade sources said.

Copper Disposals

It is announced by the Board of Trade that they are prepared to offer a further quantity of about 7,500 tons of copper for pricing and delivery before the middle of January, 1959. Of this total, about 3,000 tons of Rhodesian copper will be offered to the original suppliers, and the Board invite offers for the balance on similar terms to those announced for the recent invitation to tender.

Enquiries should be made to the Board of Trade, General Division, Lacon House, Theobalds Road, London, W.C.1 (telephone: Chancery 4411, Extension 600).

Copper Wire for South Africa

Tenders are being called for by the Stores Department of South African Railways at Johannesburg for 10,500 lb. wire, copper, solid, hard drawn, based on B.S.125/1947, and 37,100 lb. wire, copper, stranded, hard drawn, B.S.125/1947. These requirements are in five categories. A copy of the tender documents is available from the Export Services Branch of the Board of Trade, Lacon House, Theobalds Road, London, W.C.1. Tenders are to be delivered to Johannesburg by January 9, 1959.

A photo-copy of the tender documents may be obtained from the Board of Trade on payment of 8s. (Ref. ESB/28836/58.)

Parliamentary News

By Our Lobby Correspondent

Beryllium.—The Prime Minister told Mr. R. Mason (Lab., Barnsley) in the Commons that no directions had been given to the Atomic Energy Authority regarding the mining, extraction, processing and financing of the production of beryllium for the development of atomic energy.

Mr. Mason then asked to what extent there existed a partnership between the Atomic Energy Authority and Imperial Chemical Industries in regard to the production of that metal, whereby the State authority financed I.C.I. in the production of it.

Mr. Macmillan replied that the question of the production of a sufficient amount of the metal for the Atomic Energy Authority was a matter of the day-to-day administration of the Authority with which he could not interfere. The Authority informed him that it had in hand the necessary arrangements to cover its beryllium requirements.

Forthcoming Meetings

December 2—Institute of Metal Finishing. Midland Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. "Progress in Rectifiers." D. Ashby. 6.30 p.m. (Preceded by Annual General Meeting, 5.30 p.m.)

December 2—The Society of Instrument Technology. Cheltenham Section. The Rotunda, Cheltenham. "The Industrial Uses of Computers." R. H. Tizard. 7.30 p.m.

December 2 — East Midlands Metallurgical Society. Electricity Showrooms, Smithy Row, Nottingham. "Refining Nickel." H. C. Castell. 7.30 p.m.

December 3—National Association of Non-Ferrous Scrap Metal Merchants. Midland Hotel, Birmingham. Half-Yearly General Meeting. 2.30 p.m.

December 3 — Manchester Metallurgical Society. The Central Library, Manchester. "Metallurgical Control in Mass Production." J. E. James. 6.30 p.m.

December 4—Institute of Metals. London Local Section. 17 Belgrave Square, London, S.W.1. "Continuous Casting of Bronze." Dr. E. C. Ellwood. 6.30 p.m. (Joint Meeting with London Branch of the Institute of British Foundrymen.)

December 4—Leeds Metallurgical Society. Lecture Room C, Chemistry Wing, University of Leeds. "Thermodynamics in Metallurgy." J. Lunsden. 7.15 p.m.

December 4—Institute of Metal Finishing. North West Branch. Engineers' Club, Albert Square, Manchester. "Work Study in the Metal Finishing Industry," K. B. Grassby. 7.30 p.m.

December 4 — Institute of British Foundrymen. London Branch. 17 Belgrave Square, London, S.W.1. (Joint meeting with the London Local Section of the Institute of Metals.) "Continuous Casting of Bronze." Dr. E. C. Ellwood. 6.30 p.m.

Metal Market News

THE statistics for October released by the Copper Institute showed, as briefly noted last week, that world stocks of copper fell by about 100,000 short tons during the month. Details in short tons are as follows: United States production of crude copper was 111,874 tons, against 86,800 tons in September, while the refined output amounted to 113,288 tons, compared with 107,971 tons. Deliveries of refined copper, at 121,692 tons, were up by about 20,500 tons. Stocks of refined copper, at 128,490 tons, were down by 50,000 tons. Outside the United States the production of refined copper declined from 96,035 tons in September to 78,791 tons, while the output of refined was 11,000 tons down at 112,856 tons. Deliveries rose sharply, from 153,603 tons in September to 171,687 tons, while stocks declined by about 56,000 tons to 140,285 tons. While it is perhaps early days to say much about the November figures, it is by no means impossible that a further stock reduction will be seen, for Rhodesian production is only just getting into its stride and the strike at Inco still goes on. One way and another, the loss of output has been very great, and since consumption still goes on well, it would appear that reserves must have been further drawn on. Nevertheless, at the beginning of last week L.M.E. stocks were reported higher by 117 tons at 6,096 tons, the first increase for a very long time. Wall Street put up only a moderate showing, and it rather looks as though the big upward drive were coming to an end at last. In London, share prices were very steady, and the Stock Exchange was encouraged by the reduction in the Bank Rate from 4½ to 4 per cent. This, coming at a time when the pound is normally under some seasonal pressure, must be taken as a sign that the country's economy is in pretty good shape.

Nevertheless, the outlook is not altogether set fair, for industrial investment is down, and it is known that many manufacturers view the outlook for next year with some misgivings. The problem of unemployment is also to the fore, but the falling off in activity is mostly on the home market, for export sales are said to be quite up to average. However, the week opened on a very firm note, for on Monday copper jumped up by nearly £6 per ton on the stock reduction news, while lead, zinc, and to a lesser degree tin, were favourably affected by the publication of details of the American barter plan, in which these three metals are listed. Copper is not included. Monday proved to be the best day, for copper at any rate, for values fell away later in the week, Friday being a particularly poor day, ground being lost through hedging sales and liquidation in the face of an almost complete absence of consumer demand. The fall in the price in London makes it unlikely that American copper will be shipped to this side for delivery on the Metal Exchange, but it is, of course, possible that metal is on the way. Business in standard copper throughout the week was active, the turnover being 11,000 tons without Kerb transactions, which were certainly not inconsiderable. On balance, cash lost £5 10s. 0d. to close at £233, while three months was £2 15s. 0d. lower at £232.

The backwardation, it will be noted, closed in from nearly £4 to only £1, and it must be admitted that the narrowing of the gap between cash and three months has been much more rapid than was expected when the spread first began, and expanded rapidly to about £18 at its worst. Virtually all the loss in cash copper occurred on Friday, for on Thursday the settlement price was £240 but, of course, on the previous Monday it stood as high as £244. The week closed on a very gloomy note, for Wall Street suffered a sharp relapse and the Berlin situation worried the market quite a bit. The other three metals managed to score nett gains, tin being up £6 at £760 and £762 for the respective positions. The turnover was 1,225 tons. Lead gained £1 15s. 0d. prompt and £1 forward, with about 8,000 tons changing hands. Zinc was up £1 and 35s. on a turnover of 9,000 tons.

Birmingham

At the monthly meeting of the Midland Regional Board for Industry, the chairman, Maj. C. R. Dibben, said the general level of industrial activity had again fallen a little, but there were signs of a firmer basis to optimism for future prospects. The relaxation in hire purchase restrictions was benefiting industries producing such articles as washing machines, television sets, kitchenware and electrical appliances. In the capital goods industries, the slight recession continued, and the benefits to be gained from the stimulation of those industries would necessarily be slower in becoming evident. The unemployment percentage for the Region is 1·9, compared with 2·3 per cent nationally. In Birmingham itself, the percentage is 1·8.

There has been little change in the iron and steel industry. A good demand continues for raw material for the motor trade in ferrous and non-ferrous metals. Makers of heavy steel are hoping that before long there will be an upsurge in expenditure on railways and mining engineering work. At the moment, the call for heavy joists and sections is slow. Trade in heavy steel plates is moderate, and some of the tube mills have been operating short time recently. The general engineering industries absorb a substantial amount of iron castings, particularly of the heavier type. Pig iron supplies are ample for all requirements.

New York

An easier tendency for London copper was reflected in lower prices for copper futures during last weekend, with losses reaching to more than 50 points. Scrap copper was also lower, by a quarter of a cent to 24 cents for No. 2 wire. The volume at the lower level was said to be only modest. One trade source was of the opinion that if more business did not develop for scrap, another drop of a quarter of a cent might occur, but this did not materialize. Meanwhile, custom smelters and large producers were firm at their respective prices. Some quarters felt that relative quiet conditions would prevail until the November statistics were issued, adding that there was likely to be a further reduction in domestic and foreign copper stocks.

Lead and zinc were quiet and unchanged in price.

Tin eased following the London market, with business said to be small.

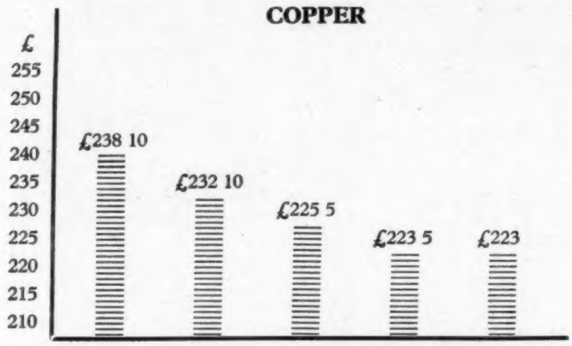
Some leading traders who, in the past, have been involved in barter transactions for minerals, say that on paper the U.S. Government's new barter regulations appear to show relaxation of recent stringent requirements, but in actuality conditions appear as difficult as before. One leading source said that the "open-end" country category (that is, where the commodity is exported with the country of destination not necessarily named in advance, while the material to be imported may come from any country in the world, excluding the Soviet bloc), seemed to be well nigh closed to barter dealings because of difficulties in selling grain to these areas under the barter terms.

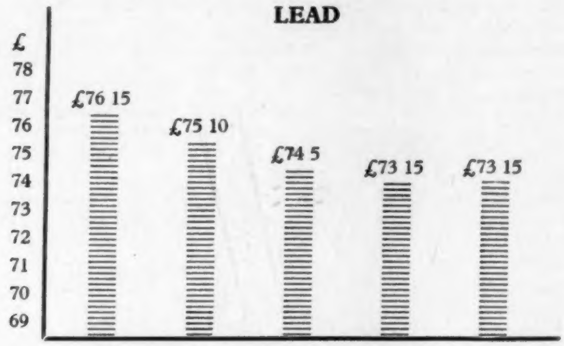
Another source said that the "open-end" category at first appeared to offer best hopes for barter deals, but on closer scrutiny it presented great difficulties. One other leading trader said the U.S. Government invited metal offerings, but things seemed to be in the preparatory stage currently as far as barter deals were concerned. These trade sources indicated that they were seeking more information and clarification from Government sources.

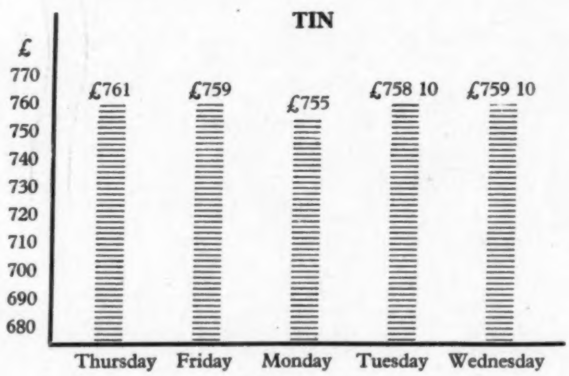
With roughly half of the October-December quarter over, latest figures from the U.S. Bureau of Customs, Department of Treasury, show that zinc metal imports are filling the quotas more rapidly than zinc ore or lead metal and ore. Imports of both lead and zinc ores are lagging behind imports of the metal.

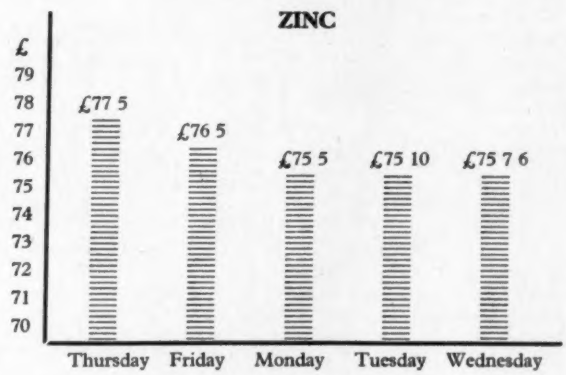
METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 20 November 1958 to Wednesday 26 November 1958









OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg	≏£/ton	Canada c/lb	≏£/ton	France fr/kg	≏£/ton	Italy lire/kg	≏£/ton	Switzerland fr/kg	≏£/ton	United States c/lb	≏£/ton
Aluminium			22.50	185 17 6	210	182 15	375	217 10	2.50	209 0	26.80	214 10
Antimony 99.0					195	169 12 6	430	249 10			29.00	232 0
Cadmium					1,500	1,305 0					145.00	1,160 0
Copper												
Crude												
Wire bars 99.9							465	269 15 0				
Electrolytic	33.75	246 15 0	28.25	233 7 6	295	256 12 6			3.15	263 10 0	29.00	232 0
Lead			11.75	97 0	115	100 0	184	106 15 0	.95	79 10 0	13.00	104 0
Magnesium												
Nickel			70.00	578 5	1,205	1,048 7 6	1,300	754 0	7.50	627 2 6	74.00	592 0
Tin	107.50	785 17 6			931	810 0	1,460	846 17 6	9.00	752 10	99.37	795 0
Zinc												
Prime western			11.50	95 0 0							11.50	92 0
High grade 99.95			12.10	100 0 0								
High grade 99.99			12.50	103 5 0								
Thermic					107.12	93 2 6						
Electrolytic					115.12	100 2 6	179	103 17 6	.93	75 5	12.75	102 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 2 p.m. 26/11/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	6
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite per unit			—	
Copper H.C. Electro	ton	223	0	0
Fire Refined 99·70%	„	222	0	0
Fire Refined 99·50%	„	221	0	0
Copper Sulphate	„	78	0	0
Germanium	grm.		—	
Gold	oz.	12	10	4¼
Indium	„		10	0
Iridium	„	20	0	0
Lanthanum	grm.		15	0
Lead English	ton	73	15	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	290	0	0
Mercury	flask	74	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	5	15	0
Platinum	„	19	10	0
Rhodium	„	40	0	0
Ruthenium	„	15	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	5⅛
Tellurium	lb.		15	0
Tin	ton	759	10	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	73	17	6
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	98	17	6
Granulated 99·99+%	„	113	6	3

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0

		£	s.	d.
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	144	0	0
B.S. 1490 L.M.2	„	152	0	0
B.S. 1490 L.M.4	„	169	0	0
B.S. 1490 L.M.6	„	187	0	0

†Average selling prices for mid September

		£	s.	d.
***Aluminium Bronze**				
BSS 1400 AB.1	ton	228	0	0
BSS 1400 AB.2	„	240	0	0
***Brass**				
BSS 1400-B3 65/35	„	150	0	0
BSS 249	„	206	0	0
BSS 1400-B6 85/15	„		—	
***Gunmetal**				
R.C.H. 3/4% ton	„		—	
(85/5/5/5)	„	185	0	0
(86/7/5/2)	„	199	0	0
(88/10/2/1)	„	253	0	0
(88/10/2/½)	„	259	0	0
Manganese Bronze				
BSS 1400 HTB1	„	186	0	0
BSS 1400 HTB2	„	207	0	0
BSS 1400 HTB3	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
B.S. 1400 P.B.1 (A.I.D. released)	„	283	0	0
B.S. 1400 L.P.B.1	„	215	0	0
Phosphor Copper				
10%	„	253	0	0
15%	„	256	0	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	357	0	0
Grade D Plumbers	„	288	6	0
Grade M	„	391	3	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	106	11	3
Mazak V	„	110	11	3
Kayem	„	116	11	3
Kayem II	„	122	11	3
Sodium-Zinc	lb.		2	6½

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

		£	s.	d.
Aluminium				
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	„		2	10½
Sheet 24 S.W.G.	„		3	1½
Strip 10 S.W.G.	„		2	8½
Strip 18 S.W.G.	„		2	9½
Strip 24 S.W.G.	„		2	11
Circles 22 S.W.G.	„		3	2½
Circles 18 S.W.G.	„		3	1½
Circles 12 S.W.G.	„		3	0½
Plate as rolled	„		2	8
Sections	„		3	2
Wire 10 S.W.G.	„		2	11½
Tubes 1 in. o.d. 16 S.W.G.	„		4	1

		£	s.	d.
Aluminium Alloys				
BS1470. HS10W.	lb.			
Sheet 10 S.W.G.	„		3	1
Sheet 18 S.W.G.	„		3	3¼
Sheet 24 S.W.G.	„		3	11
Strip 10 S.W.G.	„		3	1
Strip 18 S.W.G.	„		3	2¼
Strip 24 S.W.G.	„		3	10½
BS1477. HP30M.				
Plate as rolled	„		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	„		3	9½
Sheet 18 S.W.G.	„		4	2
Sheet 24 S.W.G.	„		5	0½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	2
Strip 24 S.W.G.	„		4	9½
BS1477. HPC15WP.				
Plate heat treated	„		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0½
BS1476. HE10WP.				
Sections	„		3	1½
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Brass Tubes	„		1	9⅝
Brazed Tubes	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	256	5	0
Extruded Bar	lb.		1	11¾
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	192	0	0
Condenser Plate (Naval Brass)	„	203	0	0
Wire	lb.		2	7⅛
Copper Tubes	lb.		2	2⅜
Sheet	ton	253	15	0
Strip	„	253	15	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	285	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	7⅛
Lead Pipes (London)	ton	115	10	0
Sheets (London)	„	113	5	0
Tellurium Lead	„	£6 extra.		
Nickel Silver				
Sheet and Strip 7%	lb.		3	8
Wire 10%	„		4	2¾
Phosphor Bronze				
Wire	„		4	0

Titanium (1,000 lb. lots)			
Billet over 4″ dia.-18″ dia.	lb.	63/-	64/-
Rod 4″ dia.-·250″ dia.	„	75/-	112/-
Wire under ·250″ dia.-·036″ dia.	„	146/-	222/-
Sheet 8′ × 2′ × ·250″-·010″ thick	„	88/-	157/-
Strip ·048″-·003″ thick	„	100/-	350/-
Tube (representative gauge)	„		300/-
Extrusions	„		120/-

		£	s.	d.
Zinc Sheets, English destinations	ton	109	10	0
Strip	„		nom.	

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 25/11/58.

	£
Aluminium	
New Cuttings	140
Old Rolled	120
Segregated Turnings	90
Brass	
Cuttings	135
Rod Ends	132
Heavy Yellow	110
Light	105
Rolled	122
Collected Scrap	108
Turnings	125
Copper	
Wire	191
Firebox, cut up	186
Heavy	176
Light	170
Cuttings	191
Turnings	170
Braziery	140
Gunmetal	
Gear Wheels	165
Admiralty	165
Commercial	151
Turnings	146
Lead	
Scrap	67
Nickel	
Cuttings	—
Anodes	500
Phosphor Bronze	
Scrap	151
Turnings	146
Zinc	
Remelted	60
Cuttings	46
Old Zinc	35

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£187.0.0)	215
Heavy copper	(£182.15.0)	210
Light copper	(£156.12.6)	180
Heavy brass	(£111.7.6)	128
Light brass	(£87.0.0)	100
Soft lead scrap	(£58.5.0)	67
Zinc scrap	(£38.5.0)	44
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£213.2.6)	245
Heavy copper	(£213.2.6)	245
Light brass	(£143.10.0)	165
Zinc castings	(£61.0.0)	70
Lead	(£86.2.6)	99
Tin		—
Aluminium	(£117.10.0)	135
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£194.7.6)	335
Aluminium copper alloy	(£124.15.0)	215
Lead, soft, first quality	(£87.0.0)	150
Lead, battery plates	(£51.0.0)	88
Copper, first grade	(£214.12.6)	370
Copper, second grade	(£203.0.0)	350
Bronze, first quality machinery	(£208.17.6)	360
Bronze, commercial gunmetal	(£179.17.6)	310
Brass, heavy	(£148.0.0)	255
Brass, light	(£136.7.6)	235
Brass, bar turnings	(£139.5.0)	240
New zinc sheet clippings	(£61.0.0)	105
Old zinc	(£46.15.0)	80

Financial News

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Chetland Industries (Birmingham) Ltd. (611834), 109 Colmore Row, Birmingham, 3. Registered September 26, 1958. To carry on business of dealers, importers and exporters and merchants and workers in metals and minerals, etc. Nominal capital, £5,000 in £1 shares. Directors: Reginald S. Chetland and Mrs. Marjorie I. Chetland.

Matthews and Lewis Limited (611958), 22 Dumfries Place, Cardiff. Registered September 29, 1958. To carry on business of metal and timber merchants, scrap merchants in timber, coal, iron, brass, etc. Nominal capital, £300 in £1 shares. Directors: Cecil A. Matthews and Wm. Lewis.

Newhaven Fabricators Ltd. (612170), Denton Corner, Seaford Road, Newhaven. Registered October 1, 1958. To carry on business of designers, makers and installers of furnaces and foundry equipment, constructional engineers, etc. Nominal capital, £2,000 in £1 shares. Directors: Roy Hall and Eileen Hall.

Arun Metals Limited (612824), Liverpool House, 15-17 Eldon Street, E.C.2. Registered October 13, 1958. Nominal capital, £1,000 in £1 shares. Directors: Ernest H. Goulding, Harold J. Jones and Leslie Jones.

Goldhill Metals Limited (612992), Golden Hillock Road, Small Heath, Birmingham, 11. Registered October 15, 1958. Nominal capital, £1,000 in £1 shares. Directors: Alfred Dobson and Fredk. J. Knight.

Hugo McGhee (Metals) Ltd (613032), 33a Powell Street, Birmingham, 1. Registered October 16, 1958. Nominal capital, £1,000 in £1 shares. Directors: Hugh A. McGhee, Eric F. West, Constance J. McGhee and Kathleen M. West.

Jones and Antcliff Limited (613478), Central Works, 4 Bailey Lane, Sheffield. Registered October 23, 1958. To take over business of brass founders and general machinists carried on as "Jones and Antcliff" at Sheffield, etc. Nominal capital, £4,000 in £1 shares. Directors: Emlyn Jones and Walter Antcliff.

Trade Publications

Metal Pressings.—Brass and Alloy Pressings (Deritend) Ltd., Liverpool Street, Birmingham, 9.

In this twelve-page booklet, a brief summary is given of the wide range of hot brass pressings, light alloy pressings, aluminium bronze pressings, and includes also some general technical information regarding these products, together with material specifications and the like. A number of excellent illustrations of such products are also given, with other useful information relating to the various sales offices of the company.

Welding Data.—Eutectic Welding Alloys Company Ltd., North Feltham Trading Estate, Faggs Road, Feltham, Middx.

A very handy pocket-sized book containing a considerable amount of useful welding data has been issued by this company. In just over 100 pages, some idea of the basic principles of their "low heat input" metal-joining process is given, together with details of some of the firm's trade names or distinctive terms, as well as an application index for their welding alloys.

Foundry Practice. — Foundry Services Ltd., Long Acre, Nechells, Birmingham, 7.

In the latest available issue of "Foseco Foundry Practice" (No. 132), a number of interesting notes on the technical services rendered by the company, together with an illustrated article on the cause of scabs on a casting, are published. Also some useful tips from contributors to the publication.

Draw Benches for Tubes.—The Head Wrightson Machine Company Ltd., Commercial Street, Middlesbrough.

A four-page leaflet in colours describes the modern tube drawbenches manufactured by this company. Useful information is given of the drawbench equipment produced and an illustration included of a 100,000 lb. capacity, triple draw, tube drawbench for drawing copper tubes up to 120 ft. long.

Cold Rolled Steel Strip and Flattened Wire.—Firth Cleveland Steel Strip Limited, Tipton, Staffs.

A 10-page illustrated brochure has been issued by this company to describe the range of cold rolled steel strip and flattened wire recently introduced by them under the trade mark of "Fircleve." In addition to illustrating the range of Fircleve steel strip by means of unusual coloured graphs, the brochure contains much useful information on the properties and applications of various grades of strip, including clearly drawn graphic hardness comparison and equivalent tensile strength tables.

Welding Aluminium. — Northern Aluminium Company Ltd., Banbury, Oxon.

Since this company first issued their book on welding aluminium some 3½ years ago, great advances have been made in both technique and the amount and scope of work done. An extensively revised edition of the book has now been produced and, as before, deals almost exclusively with the two shrouded arc processes, "argon tungsten arc" and "inert metal arc," and much of the space is taken up with tables of procedures.

THE STOCK EXCHANGE

Prices Reacted Sharply Following Weakness On Wall Street

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 25 NOVEMBER	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	24/3	—6d.	9	10	7 8 6	24/9	17/6	28/3	18/–
400,000	2/–	Anti-Attrition Metal	1/7½		4	8½	4 18 6	1/7½	1/3	2/6	1/6
33,639,483	Stk. (£1)	Associated Electrical Industries ...	55/3	—1/6	15	15	5 8 6	57/9	46/6	72/3	47/9
1,590,000	1	Birfield	58/6		15	15	5 2 6	62/4½	46/3	70/–	48/9
3,196,667	1	Birmid Industries	64/–	—9d.	17½	17½	5 6 9	77/–	55/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	34/6	—6d.	11	10	6 7 6	37/3	23/9	33/–	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/–		5	5	6 13 3	16/1½	14/7½	16/–	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/1½		6	6	7 0 3	17/4½	16/6	19/–	16/6
500,000	1	Bolton (Thos.) & Sons	26/3		10	12½	7 12 6	28/9	24/–	30/3	28/9
300,000	1	Ditto Pref. 5%	15/–		5	5	6 13 3	16/–	15/–	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/–	—4½d.	7	7	7 0 0	20/4½	19/–	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.	57/6	—3/3	12	12	4 3 6	61/6	36/6	72/–	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	19/6		6	6	6 3 0	20/–	18/4½	21/6	18/–
15,000,000	Stk. (£1)	British Insulated Callender's Cables	50/6	—3d.	12½	12½	4 19 0	52/–	38/9	55/–	40/–
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	42/–	—3/–	10	10	4 15 3	47/–	28/3	39/–	29/6
600,000	Stk. (5/–)	Canning (W.) & Co.	24/3		25+ *2½C	25	5 3 0	24/6	19/7½	24/6	19/3
60,484	1/–	Carr (Chas.)	1/6		25	25	11 13 3	2/3	1/4½	3/6	2/1½
150,000	2/–	Case (Alfred) & Co. Ltd.	5/–	+1½d.	25	25	10 0 0	5/3	4/–	4/6	4/–
555,000	1	Clifford (Chas.) Ltd.	21/–		10	10	9 10 6	21/–	16/–	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/6		6	6	7 14 9	16/–	15/–	17/6	16/–
250,000	2/–	Coley Metals	3/–		20	25	13 6 9	4/6	2/6	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	56/6		18¾	22½	6 19 9	58/–	41/–	92/6	49/–
1,136,233	1	Davy & United	80/–	+5/–	20	15	5 0 0	80/–	45/9	60/6	42/6
2,750,000	5/–	Delta Metal	24/6	—4½d.	30	*17½	6 2 6	24/10½	17/7½	28/6	19/–
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	35/–	—3/–	12½	15B	7 3 0	38/–	22/9	38/6	25/–
750,000	1	Evered & Co.	28/–		15Z	15	7 2 9	28/3	26/–	52/9	42/–
18,000,000	Stk. (£1)	General Electric Co.	34/9	—1/–	10	12½	5 15 0	39/6	29/6	59/–	38/–
1,500,000	Stk. (10/–)	General Refractories Ltd.	35/9		20	17½	5 12 0	37/6	27/3	37/–	26/9
401,240	1	Gibbons (Dudley) Ltd.	67/6	+2/1½	15	15	4 9 0	67/6	61/–	71/–	53/–
750,000	5/–	Glacier Metal Co. Ltd.	7/–		11¼	11¼	8 4 3	7/9	5/6	8/1½	5/10½
1,750,000	5/–	Glynwed Tubes	16/7½		20	20	6 0 3	18/1½	12/10½	18/–	12/6
5,421,049	10/–	Goodlass Wall & Lead Industries ...	28/3		13‖	18Z	4 12 0	28/3	19/3	37/3	28/9
342,195	1	Greenwood & Batley	55/–	+2/6	20	17½	7 5 6	55/–	45/–	50/–	46/–
396,000	5/–	Harrison (B'ham) Ord.	15/9		*15	*15	4 15 3	15/9	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	19/9		7	7	7 1 9	19/9	18/4½	22/3	18/7½
1,075,167	5/–	Heenan Group	7/4½	—10½d.	10	10‡	6 15 6	9/7½	6/9	10/4½	6/9
236,953,260	Stk. (£1)	Imperial Chemical Industries ...	34/9	—1/–	12Z	10	4 12 0	36/3	27/7½	46/6	36/3
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/9		5	5	5 19 6	17/1½	16/–	18/6	15/6
14,584,025	**	International Nickel	148½	—1½	$3.75	$3.75	4 4 3	169	132¾	222	130
430,000	5/–	Jenks (E. P.), Ltd.	8/9		27½ϕ	27½	7 17 3	8/10½	6/7½	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/9	15/–	17/–	14/6
3,987,435	1	Ditto Ord.	46/–	+1/–	10	10	4 7 0	46/–	36/6	58/9	40/–
600,000	10/–	Keith, Blackman	27/6		17½	15	6 7 3	27/6	15/–	21/9	15/–
160,000	4/–	London Aluminium	5/1½	+1½d.	10	10	7 16 0	5/1½	3/–	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord. ...	60/–	—4/–	12½	12½	4 3 3	64/–	39/9	54/6	41/–
400,000	1	Ditto Pref.	23/10½		7½	7½	6 5 9	23/10½	22/3	25/3	21/9
765,012	1	McKechnie Brothers Ord.	43/–	+6d.	15	15	6 19 6	44/–	32/–	48/9	37/6
1,530,024	1	Ditto A Ord.	44/6	+2/–	15	15	6 14 9	45/–	30/–	47/6	36/–
1,108,268	5/–	Manganese Bronze & Brass	13/6		20	27½‡	7 8 3	13/9	8/9	21/10½	7/6
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	6/3	5/9	6/6	5/–
13,098,855	Stk. (£1)	Metal Box	62/6	—6d.	11	11	3 10 6	64/–	41/9	59/–	40/3
415,760	Stk. (2/–)	Metal Traders	8/9		50	50	11 8 6	8/9	6/3	8/–	6/3
160,000	1	Mint (The) Birmingham	20/–		10	10	10 0 0	22/9	19/–	25/–	21/6
80,000	5	Ditto Pref. 6%	70/6		6	6	8 10 3	83/6	70/6	90/6	83/6
3,705,670	Stk. (£1)	Morgan Crucible A	42/3		10	10	4 14 9	42/3	34/–	54/–	35/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6	—1½d.	5½	5½	6 5 9	17/9	17/–	19/3	16/–
2,200,000	Stk (£1)	Murex	52/–	—9d.	17½	20	6 14 6	58/9	47/9	79/9	57/–
468,000	5/–	Ratcliffs (Great Bridge)	10/6		10	10	4 5 3	11/1½	6/10½	8/–	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	24/6xd	—1/–	20	27½D	8 3 3	27/–	24/6	41/–	24/9
1,365,000	Stk. (5/–)	Serck	17/9	+4½d.	15	17½	4 4 6	17/9	11/–	18/10½	11/6
6,698,586	Stk. (£1)	Stone-Platt Industries	44/–	+3d.	15	12½	6 16 3	44/–	22/6	33/4½	22/7½
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	16/–		5½	5½	6 17 6	16/–	12/7½	14/–	12/9
14,494,862	Stk. (£1)	Tube Investments Ord.	76/9	+3d.	17½	15	4 11 3	77/10½	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	34/3	—9d.	10	10	5 16 9	35/9	28/9	46/–	29/–
750,000	Stk. (£1)	Ditto Pref. 5%	15/6		5	5	6 9 0	15/6	14/3	18/–	14/–
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	22/–		*5	*5	7 0 3A	23/–	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	81/6	+1/–	20	15	4 18 3	87/–	70/9	83/–	64/–
2,666,034	Stk. (£1)	Westinghouse Brake	43/–		10	18P	4 15 9	43/–	32/6	85/–	29/1½
225,000	2/–	Wolverhampton Die-Casting ...	10/–		30	25	6 0 0	10/1½	7/–	10/1½	7/–
591,000	5/–	Wolverhampton Metal	21/3	+6d.	27½	27½	6 9 6	22/9	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gell	4/6		20	17½E	11 2 3	4/10½	2/9	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	13/–		6	6	9 4 6	13/–	11/3	12/6	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/9		27	40D	9 16 3	3/1½	2/7½	5/–	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% Capitalized issue. • The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share for £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits.